United States Court of Appeals

for the Second Circuit

APPENDIX

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United States Court of Appeals
For the Second Circuit

EUTECTIC CORPORATION, NEW METALS CORPORATION and METALLIZING COMPANY OF AMERICA, INC.,

Plaintiffs-Appellees and Cross-Appellants,

v.

METCO, INC.,

Defendant-Appellant and Cross-Appellee.

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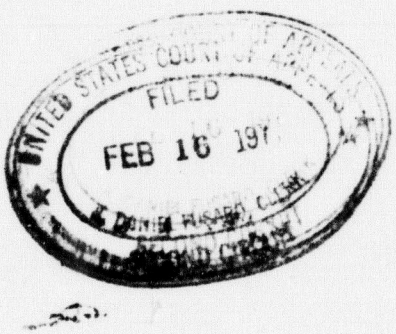

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The Court is respectfully requested to disregard the underlinings, marginal notations, asterisks and other markings of plaintiffs' counsel appearing on the pages reproduced in the Joint Appendix.

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1-24-72	Declaratory Judgment Complaint filed.
2-14-72	AMENDED DECLARATORY JUDGMENT COMPLAINT FILED.
3-26-73	ANSWER and counterclaim filed.
4- 2-73	Reply to counterclaim filed.
7-14-76	By NEAHER, J—Memorandum & Order dtd 7-13-76 that judgment is directed declaring that the patent claims in suit are valid as construed herein but are not infringed by pltffs' accused powders, and dismissing deft's counterclaim on the merits. Submit proposed forms of judgment on notice filed.
9- 1-76	By NEAHER, J—JUDGMENT dtd 8-31-76.
9-30-76	Notice of appeal from deft filed. copies mailed.
10-13-76	Cross notice of appeal filed. Copy to adv. & C of A. (pltff)

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF NEW YORK

EUTECTIC CORPORATION and NEW METALS CORPORATION, Plaintiffs, v. METCO, INC., Defendant.	CIVIL ACTION No. 72 C 102

DECLARATORY JUDGMENT COMPLAINT

Plaintiffs, Eutectic Corporation, Inc., and New Metals Corporation, for their complaint against defendant, Metco, Inc., allege:

1. Plaintiffs are both corporations organized and existing under the laws of the State of New York, and both have a principal place of business at 40-40 172nd Street, Flushing, New York.

2. Defendant is a corporation organized under the laws of the State of Delaware, having a place of business at 1101 Prospect Avenue, Westbury, Long Island.

3. This suit arises out of an actual controversy between the parties as to the validity and scope of three United States Letters Patent, and jurisdiction is conferred on this Court by Judicial Code, 28 U.S.C. 1330 and 2201.

4. Plaintiff, Eutectic Corporation, Inc., is engaged, amont other things, in the manufacture and sale of welding and soldering metals, alloys, and related products.

5. Plaintiff, New Metals Corporation, is a wholly owned subsidiary of Eutectic Corporation, Inc. and purchases welding and soldering metals, alloys and related products from said Eutectic Corporation, Inc. and sells such products to the trade

6. Defendant asserts ownership of the following United States Letters Patent:

PATENT No.	PATENTEE	DATE	TITLE
3,322,515	F.J. Dittrich et al	5/30/67	FLAME SPRAYING EXOTHERMICALLY REACTING INTERMET-ALLIC COMPOUND FORMIN COMPOSITES
3,254,970	F.J. Dittrich et al	6/7/66	FLAME SPRAY CLAD POWDER COMPOSED OF A REFRACTORY MATERIAL AND NICKEL OR COBALT

7. Defendant has threatened a customer of plaintiffs' with a suit for patent infringement for the purchase of compounds and/or powders allegedly covered by the above patents from New Metals, which compounds and/or powders were manufactured by Eutectic Corporation.

8. The aforesaid patents are each invalid for lack of patentable invention over the prior art under 35 U.S.C. 102, 103 and 112, among other reasons.

9. The claims of the aforesaid patents are not infringed by plaintiffs' manufacture and sale of the subject compounds and/or powders.

10. Prompt adjudication of the controversy between the parties is desirable and in the interest of the parties as well as in the interest of the public.

WHEREFORE, plaintiffs pray:

A. For a judgment declaring that each of said patents are invalid and void;

B. For a judgment declaring that such manufacture, use and sale by plaintiffs, or their vendors, or others in privity with them, do not constitute infringement of the claims of said patents.

C. For an injunction restraining defendant and anyone in privity with defendant from asserting infringement or threatening or prosecuting an action charging infringement of said patents against plaintiffs or any of their distributors, dealers or vendees, or others in privity with any of them, based upon the manufacture, use and sale of flame spraying exothermically reacting intermetallic compound forming composites, and flame spray clad powder composed of a refractory material and nickel or cobalt, manufactured and sold by plaintiffs; and

D. For such further relief as may be just and proper including plaintiffs' costs and attorneys' fees.

EUTECTIC CORPORATION
NEW METALS CORPORATION

John M. Calimafde.

John M. Calimafde
Attorney for Plaintiff
Sandoe, Hopgood & Calimafde
60 E. 42nd St.
New York, N.Y. 10017
(212) 986-2480

Dated: January 24, 1972

Of Counsel:

Eugene J. Kalil
Robert Schroeder

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF NEW YORK

EUTECTIC CORPORATION, NEW METALS CORPORATION, and METALLIZING CO. OF AMERICA, INC., Plaintiffs, v. METCO, INC., Defendant.	Civil Action No. 72 C 102

AMENDED DECLARATORY JUDGMENT COMPLAINT

Plaintiffs, Eutectic Corporation, New Metals Corporation, and Metallizing Company of America, Inc., for their complaint against defendant, Metco, Inc., allege:

1. Plaintiffs, Eutectic Corporation and Mew Metals Corporation are both corporations organized and existing under the laws of the State of New York, and both have a principal place of business at 40-40 172nd Street, Flushing, New York.

2. Metallizing Company of America, Inc. is a corporation organized and existing under the laws of the State of Illinois, having a regular and established place of business at 3520 West Carroll Avenue, Chicago, Illinois.

3. Defendant is a corporation organized under the laws of the State of Delaware, having a place of business at 1101 Prospect Avenue, Westbury, Long Island, New York.

4. This suit arises out of an actual controversy between the parties as to the validity and scope of three United States Letters Patent, and jurisdiction is conferred on this Court by Judicial Code, 28 U.S.C. 1330 and 2201.

5. Plaintiff, Eutectic Corporation, is engaged, among other things, in the manufacture and sale of welding and soldering metals, alloys, and related products.

6. Plaintiff, New Metals Corporation, is a wholly owned subsidiary of Eutectic Corporation and purchases welding and soldering metals, alloys and related products from said Eutectic Corporation and sells such products to the trade.

7. Plaintiff, Metallizing Company of America, purchases certain flame-spraying powders from plaintiff New Metals, which powders are manufactured by plaintiff Eutectic.

8. Defendant asserts ownership in the following United States Letters Patents:

PATENT No.	PATENTEE	DATE	TITLE
3,322,515	F.J. Dittrich et al	5/30/67	FLAME SPRAYING EXOTHERMICALLY REACTING INTERMETALLIC COMPOUND FORMING COMPOSITES
3,254,970	F.J. Dittrich et al	6/7/66	FLAME SPRAY CLAD POWDER COMPOSED OF A REFRACTORY MATERIAL AND NICKEL OR COBALT
3,436,248	F.J. Dittrich et al	4/1/69	FLAME SPRAYING EXOTHERMICALLY REACTING INTERMETALLIC COMPOUND FORMING COMPOSITES

9. Defendant has threatened Metallizing with a suit for patent infringement for the purchase of compounds and/or powders allegedly covered by the above patents from New Metals, which compounds and/or powders allegedly covered by the above patents from New Metals, which compounds and/or powders were manufactured by Eutectic.

10. The aforesaid patents are invalid for lack of patentable invention over the prior art under 35 U.S.C. 102, 103 and 112, among other reasons.

11. The claims of the aforesaid patents are not infringed by plaintiffs' manufacture and sale of the subject compounds and/or powders.

12. Prompt adjudication of the controversy between the parties is desirable and in the interest of the parties as well as in the interest of the public.

WHEREFORE, plaintiffs pray:

A. For a judgment declaring that each of said patents is invalid and void;

B. For a judgment declaring that such manufacture, use and sale by plaintiffs, or their vendors, or others in privity with them, do not constitute infringement of the claims of said patents.

C. For an injunction restraining defendant and anyone in privity with defendant from asserting infringement or threatening or prosecuting an action charging infringement of said patents against plaintiffs or any of their distributors, dealers or vendees, or others in privity with any of them, based upon the manufacture, use and sale of flame spraying exothermically reacting intermetallic compound forming composites and flame spraying composite powder composed of a refractory material and nickel or cobalt, manufactured and sold by plaintiffs; and

D. For such further relief as may be just and proper including plaintiffs' costs and attorneys' fees.

EUTECTIC CORPORATION
NEW METALS CORPORATION
METALLIZING COMPANY OF AMERICA, INC.

John M. Calimafde
Attorney for Plaintiff
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60 E. 42nd St.
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(212) 986-2480

Dated:

Of Counsel:

Eugene J. Kalil
Marvin N. Gordon
Robert A. Schroeder

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF NEW YORK

EUTECTIC CORPORATION, NEW METALS CORPORATION, and METALLIZING COMPANY OF AMERICA, INC., Plaintiffs,	Civil Action No. 72 Civ. 102
v.	
METCO, INC., Defendant.	

ANSWER AND COUNTERCLAIM

Defendant, Metco, Inc., for its answer to the amended complaint:

1. Denies the allegations as set forth in Paragraph 4 of the amended complaint with respect to United States Patent 3,254,970.

2. Denies the allegations as set forth in Paragraph 9 of the amended complaint with respect to United States Patent 3,254,970.

3. Denies the allegations as set forth in Paragraphs 10 and 11 of the amended complaint.

Counterclaim

4. Jurisdiction arises under the patent laws of the United States and by virtue of the complaint filed by plaintiffs-counterdefendants herein.

5. On May 30, 1967, United States Letters Patent 3,322,515 were duly and legally issued to defendant-counterclaimant's predecessor in interest, Metco, Inc., a New Jersey corporation, for an invention in the field of flame spraying.

6. On April 1, 1969, United States Letters Patent 3,436,248 were duly and legally issued to defendant-counterclaimant's predecessor in interest, Metco, Inc., a New Jersey corporation, for an invention in the field of flame spraying.

7. On September 30, 1971, the above-identified Letters Patents, together with all claims for damages by reason of past infringement, were assigned to defendant-counterclaimant, and since that date defendant-counterclaimant has been and still is the owner of said Letters Patents.

8. Though plaintiff-counterdefendants have had notice of these patents, they have willfully and deliberately infringed and contributorily infringed the claims thereof by; manufacturing and selling flame spray materials; by flame spraying; and by inducing others to flame spray, and selling flame spray materials to others for this purpose, and will continue to do so, to the irreparable injury of defendant-counterclaimant, unless enjoined by this Court.

WHEREFORE, defendant-counterclaimant demands:

I. That the complaint be dismissed;

II. That plaintiff-counterdefendants, their agents, servants, employees and others in privy or controlled by plaintiff-counterdefendants be temporarily and permanently enjoined and restrained from infringing, contributorily infringing and inducing infringement of the aforesaid Letters Patents;

III. That plaintiff-counterdefendants be required to account to defendant-counterclaimant for all profits realized from said infringement and for all damages sustained and due thereto, and that such damages be trebled.

IV. That reasonable attorneys' fees and costs be assessed against plaintiff-counterdefendants, and that defendant-counterclaimant be granted such other and further relief as the Court may deem just and proper in the premises.

METCO, INC.

By: _____
Arnold Sprung
BURGESS, DINKLAGE & SPRUNG
600 Third Avenue
New York, New York 10016

Date:

(212) 661-0520

OF COUNSEL:

Nathaniel D. Kramer
BURGESS, DINKLAGE & SPRUNG
600 Third Avenue
New York, New York 10016

CERTIFICATE OF SERVICE

I hereby state under Penalty of Perjury that a True Copy of the foregoing is today mailed to Counsel for the opposing ~~party~~ (parties).....

Date: 3/23/73 Nathaniel D. Kramer
NATHANIEL D. KRAMER

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF NEW YORK

EUTECTIC CORPORATION, NEW METALS CORPORATION, and METALLIZING COMPANY OF AMERICA, INC., Plaintiffs,	Civil Action No. 72 Civ. 102
v.	
METCO, INC., Defendant.	

REPLY TO COUNTERCLAIM

Plaintiffs-Counterdefendants in reply to defendant's counterclaim allege as follows:

1

Paragraph 4 of the Counterclaim is admitted.

2

Plaintiffs admit that United States Letters Patent 3,322,515, issued on May 30, 1967, but denies that the patent was duly and legally issued. Plaintiffs have no knowledge regarding the original ownership of the patent and leave defendant to its proofs.

3

Plaintiffs admit that United States Letters Patent 3,436,248, issued on April 1, 1969, but denies that the patent was duly and legally issued. Plaintiffs have no knowledge regarding the original ownership of the patent and leave defendant to its proofs.

4

Plaintiffs have no knowledge of the allegations conferred in paragraph 7 of the counterclaim and leave defendant to its proofs.

5

Plaintiffs deny each and every allegation conferred in paragraph 8 of the counterclaim.

WHEREFORE plaintiffs pray that the counterclaim be dismissed with costs, and that reasonable attorneys fees be awarded to plaintiffs, and that plaintiffs have judgment against the defendant, and such other and further relief as to the Court may seem just and equitable.

EUTECTIC CORPORATION,
NEW METALS CORPORATION, and
METALLIZING COMPANY OF AMERICA, INC.

By John M. Calimafde

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Of Counsel:

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AFFIDAVIT OF SERVICE

STATE OF NEW YORK)
)SS.:
COUNTY OF NEW YORK)

PATRICIA A. SCOTT, being duly sworn, deposes and says, I am not a party to this action, I am over 18 years of age and reside at 60 East 42nd Street, New York, New York; that on the 29th day of March, 1973, I served the within REPLY TO COUNTERCLAIM upon Burgess, Dinklage & Sprung, the Attorneys for Defendant in this action, at 600 Third Avenue, New York, New York 10016, the address designated by said attorneys for that purpose, by depositing a true copy of same enclosed in a postpaid properly addressed wrapper, in an official depository under the exclusive care and custody of the United States post office department within the State of New York

Patricia A. Scott
Patricia A. Scott

Sworn to before me this
29th day of March, 1973.

Nancy E. Utt
Notary Public

NANCY E. UTT
Notary Public, State of New York
No. 03-9419230
Qualified in Bronx County
Commission Expires March 30, 1974

FILED
IN CLERK'S OFFICE
U. S. DISTRICT COURT E.D. N.Y.
JUL 14 1976
TIME A.M.
P.M.

JA 16

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF NEW YORK

- - - - - - - - - - - - - - - - - - - -x

EUTECTIC CORPORATION, NEW METALS CORPORATION, and METALLIZING COMPANY OF AMERICA, INC.,

Plaintiffs,

-against-

METCO, INC.,

Defendant.

- - - - - - - - - - - - - - - - - - - -x

72 C 102

MEMORANDUM OF DECISION

APPEARANCES:

SANDOE, HOPGOOD & CALIMAFDE
Attorneys for Plaintiffs
By JOHN M. CALIMAFDE, ESQ.
(EUGENE J. KALIL, ESQ., MARVIN N. GORDON, ESQ. and G. HARRY KAPRALOS, ESQ., of Counsel)

BURGESS, DINKLAGE & SPRUNG
Attorneys for Defendant
By ARNOLD SPRUNG, ESQ.
(NATHANIEL D. KRAMER, ESQ., of Counsel)

NEAHER, District Judge.

This action, which was tried by the court on the facts, involves questions of validity and infringement of United States Patent 3,322,515 (the '515 patent) and United

States Patent 3,436,248 (the '248 patent) owned by defendant Metco, Inc. The action was begun by plaintiffs as a declaratory judgment action, requesting a declaration of non-infringement and invalidity of the patents. Defendant counterclaimed, charging infringement by each plaintiff. Jurisdiction is grounded on the patent laws of the United States, 28 U.S.C. §1338.

Preliminary Statement

Plaintiff Eutectic Corporation ("Eutectic") and plaintiff New Metals Corporation ("New Metals"), its wholly-owned subsidiary, are New York corporations, having their principal place of business in Flushing, New York. Plaintiff Metallizing Company of America ("Metallizing"), a customer of Eutectic, is an Illinois corporation having its principal place of business in Chicago, Illinois. Defendant Metco, Inc. ("Metco") is a Delaware corporation having its principal place of business in Westbury, New York.

Eutectic, since its founding in 1940, has been engaged in developing, manufacturing and marketing special alloys, torch equipment and other consumable products utilized in the soldering, brazing and welding field. In 1970

Eutectic announced the development of a new exothermic nickel-aluminum powder tradenamed "Exotec," which would eliminate the need for a subsequent fusing operation in order to bond a metal coating using Eutectic's "Spram" process for spray welding applications in the glass mold industry. Subsequently, Eutectic developed its own "Roto-Tec" flame spray process based upon Exotec and added "Durotec" and "XuperBond" powders to its product line. All of these products are basically nickel-aluminum compositions.

Metco has been in the business of manufacturing and selling metallizing and flame spraying equipment and providing related materials and technical services since before 1938. It claims that Eutectic's Exotec, Durotec and XuperBond products are infringing copies of a series of nickel-aluminum self-bonding flame spray powders Metco had developed about 1960, and which it had begun successfully marketing in 1963, subsequent to the filing of the patent application that eventually led to the issuance of the '515 and '248 patents on the Metco powders and process.

Metco originally commenced this litigation in the Northern District of Illinois[1] against Metallizing because of

the latter's sale of a product called "Moguloy M-55", which Metco claims also infringes the patents in suit. Metallizing has been in the flame spray field since the 1920's and had previously marketed a Metco-patented molybdenum flame spray material hereinafter mentioned. Moguloy M-55 was Metallizing's first venture into nickel-aluminum powder, a product manufactured by Eutectic which Metallizing purchased through Eutectic's subsidiary, New Metals.

Plaintiffs challenge the validity of the Metco patents on a variety of grounds: (1) the claimed invention was fully anticipated by prior patents; (2) the use of composite nickel-aluminum powder for flame spraying as described in the patents would have been obvious to one having ordinary skill in the art, and Metco's employees simply obtained a patent on coated powders purchased from a producer of such materials; and (3) the '515 patent claims merely an unpatentable new "use" for a known material, and the '248 patent an admittedly conventional process for spraying the material covered by the '515 patent. Plaintiffs also deny infringement, claiming that the Eutectic powders, including Moguloy M-55, are different from Metco's products and not covered by the literal terms of the patents.

The Industrial Art Involved

The patents in suit relate to the industrial technique of flame spraying, formerly known as metallizing. Flame spraying is a process for applying a metal, a ceramic (metal oxide), or a mixed metal/ceramic (cermet) coating in a molten state to another metal surface (also called substrate) to form a bond between the two that will permit the coated surface (or object) to undergo further finishing operations, resist corrosion, or withstand high temperatures or other wear and stress during use. The coating to be sprayed on the substrate is commonly referred to as "flame spray material." The flame spray material, which may be in rod, wire or powder form, is fed into a device called a "flame spray gun." As the flame spray material passes through the gun it is reduced by gas-oxygen or electric arc flame to a molten or semi-molten state and propelled in atomized form onto the surface to be coated, much as paint is sprayed.

From the original development of flame spraying about the turn of the century until the 1940's, the only practicable method of assuring some degree of adhesion (bond strength) between a flame spray coating and a metal surface

was to mechanically roughen the surface by grit blasting, cutting threads and the like, so as to provide crevices or undercuts into which the sprayed molten particles would enter, forming a mechanical interlock. The first commercial utilizations of flame spraying were in connection with relatively low melting point metals sprayed through a wire gun in order to produce corrosion-resistant and decorative metal coatings. It was during this period that the process was known as "metallizing."

Although improvements were subsequently made in metallizing guns and materials and the mechanical treatment of surfaces, no significant commercial development occurred until the mid-1940's when Arthur P. Shepard, a Metco engineer and deceased co-patentee of the patents in suit, discovered the self-bonding properties of molybdenum as a flame spray material. He found that molybdenum, when prepared in wire form and sprayed onto a clean unroughened surface, would self-bond to form a base coating with a high bond strength (about 2,000 psi), to which subsequently applied flame spray materials would also tenaciously adhere. Shepard was granted U.S. Patent 2,588,421 on that discovery, and molybdenum wire remained the only known and widely used self-bonding material

in the flame spray field for almost 15 years.

Molybdenum wire, despite its commercial success, had a number of disadvantages. It was difficult and messy to use; caused wear on equipment because of its hardness; could only be applied at a relatively slow spray rate; would not satisfactorily bond to copper, copper alloy, or nitrided surfaces; required a high degree of operator skill for satisfactory application; and could not be used where the part being sprayed would subsequently be subjected to use at temperatures above 600°. At such temperatures, the molybdenum would oxidize and deteriorate, destroying the bond. Efforts to overcome some of these problems by attempting to spray molybdenum in powder form were not successful.

It is Metco's claim in this action — sharply controverted by plaintiffs — that another Metco engineer, Ferdinand J. Dittrich, working under Shepard, made the next important advance in the art which resulted in the patents in sui.. This took the form of a self-bonding flame spray powder of nickel-aluminum composite granules which Metco originally introduced as "Metco 404" in 1964, while the patent applications were pending. Metco asserts the new powder

overcame practically all the disadvantages of molybdenum wire, was widely accepted in the flame spray field as replacing molybdenum to a large extent, and has enjoyed great commercial success.

The Patents and Claims in Issue

Metco's '515 patent issued to Dittrich and Shepard on May 30, 1967, on an application filed March 25, 1965 as a continuation-in-part of earlier applications dating back to November 22, 1960 and is directed to a product, a flame spray material in powder or wire form. The '248 patent to the same patentees issued on April 1, 1969 on an application filed May 26, 1966 as a division of the application resulting in the '515 patent. It is directed to a process of flame spraying the material disclosed in the '515 patent.[2] Both patents were later assigned to Metco by the patentees.

Claims 4 and 14 of the '515 patent and Claims 1 and 4 of the '248 patent, quoted in the margin, constitute the matter substantially in issue between the parties.[3] Those claims teach the composition and process of spraying a flame spray powder of aluminum and nickel in composite form, which has the ability of generating additional heat in an exothermic

reaction during spraying. It is that heat which is claimed to aid the resultant nickel aluminide coating to self-bond, i.e., adhere firmly, to smooth, clean metal surfaces as well as conventionally roughened surfaces.

A novel element claimed to contribute to the "unexpected" self-bonding results of the patented powder (or wire) is its "composite" form. The term "composite" in the patent designates not a mere mixture of powdered component metals but "a structurally integral unit" in which each granule of powder contains particles of nickel and aluminum bound in close contact with each other by a dry film binder.[4] The patent also describes a simplified method of "cladding" the component metals so as to form the required composite.[5]

In sum, the patented invention under the claims in issue consists of the following elements: (a) a composite of powdered aluminum and nickel (b) each particle unit thereof comprising a nucleus of nickel clad with finely divided aluminum particles bound together by a resin binder, (c) capable of releasing heat of at least 7500 calories per gram atom in an exothermic reaction during flame-spraying,

(d) which produces an adherent self-bonded coating on a clean unheated and unroughened metal surface.

Plaintiffs do not question the utility of the flame spraying materials described in the claims in suit.[6] Their primary contention, simply stated, is that the patents are invalid because they teach merely the application of metallurgical principles and techniques already revealed in the prior art. It is well known, plaintiffs point out, that certain pairs of metals such as aluminum and nickel will, when heated together at suitable temperatures and proportions, react exothermically, that is, release a surplus quantity of heat to form an intermetallic compound such as nickel aluminide. This metallurgical effect, say plaintiffs, is disclosed in many earlier patents which render the claimed invention neither novel nor unobvious to one having ordinary skill in the art. Plaintiffs further contend that after rejecting five prior applications by the patentees, the examiner was prevailed upon in an ex parte interview to allow the '515 patent to issue upon the fifth refiling and did so without being fully informed as to the prior art. The grant of the '515 patent led, in turn, to the issuance of the '248 patent.

To decide the questions of the lack of novelty and of obviousness or non-obviousness of the subject matter of the patents, "the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved." Graham v. John Deere Co., 383 U.S. 1, 17-18 (1966).

In this case, since plaintiffs claim as "prior art" certain "early work" of Dittrich, the surviving co-patentee,[7] and question the manner in which the patents were obtained, a chronological presentation hopefully will illumine discussion of the Graham issues which follow.

SCOPE AND CONTENT OF PRIOR ART

Patentee's Early Work

Dittrich has been employed by Metco as an engineer since 1938. He was called by plaintiffs to testify concerning his early familiarity with the subject matter. After describing in general terms Metco's "experimental" interest in the developing field for metal spray powders in the period 1946-1955, Dittrich was particularly queried about work Metco

had done for Climax Molybdenum Company during 1951-1954 on so-called "layered coatings" of nickel-aluminum.

Climax at that time was seeking to prevent failures which occurred in molybdenum sheet metal used in jet engines because of its high oxidation rate at elevated temperatures. Dittrich participated in the experimental flame spraying work on panels of metal which were heat-tested in Climax's own laboratories. Through his own study of the available technical literature, he was aware it was "common knowledge" that nickel and aluminum were exothermic materials which would react in combination to form the intermetallic compound nickel aluminide, generating heat in the process, and that nickel aluminide had high oxidation resistance properties. In his work on the Climax problem he sprayed alternating layers of melted aluminum powder and melted nickel powder on metal panels without obtaining the desired exothermic reaction. Nor did he obtain such a reaction when he sprayed powder mixtures of nickel and aluminum.

After the "unsuccessful" work on the Climax problem, Dittrich continued intermittent spraying of layered coatings at Metco in attempts to obtain an exothermic reaction on the

surface of a sprayed panel. He utilized not only nickel and aluminum but also aluminum and other metals. He continued this experimentation, he testified, with the thought that a reaction of combined metals on the surface of a substrate would provide both bonding and other qualities desired in the coating. Unable to accomplish this, he tried removing the layered coatings from the substrate and heating the sandwiched constructions with a torch. His findings on these sandwich experiments are summarized in an internal Metco memorandum dated October 6, 1955, captioned "Combination (Exothermic) Reactions Upon Heating Layered Coatings of Various Metals." PX 16. There he reported:

> "Rapid local overheating of one corner of a Ni-al sandwich will trigger a vairly violent exothermic reaction with the resulting alloying of the Ni and Al. The entire mass of the sheet will coalesce into pools of the alloy formed."

The reported results, he testified, led him to conclude then that a "composite" of nickel and aluminum in close physical contact, if reduced to the right particle size, appeared to be "a possibility" for use in flame spraying to obtain a sprayed coating with a good bond and the high oxidation resistance of nickel aluminide. Although acknowledging

that both nickel and aluminum powders were then available, Metco made no effort to develop such a concept. Dittrich testified, in explanation, that Metco had no equipment for "agglomerating" metal particles and its homemade ball milling equipment was not adequate for the necessary grinding and sizing. Instead, Dittrich continued reviewing the literature, looking for a commercial means of obtaining such particles.[8]

Sometime in 1959 Dittrich found what he thought he was looking for in a publicized announcement of the Sherritt Gordon Mines Ltd. of Alberta, Canada. PX 52. The announcement stated that Sherritt Gordon would soon make available on a semi-commercial basis "metal and nonmetal powders coated with nickel, cobalt, copper and other metals" that "promise improved properties for powdered-metal and metal-ceramic parts." The announcement also mentioned particle size ranges which Dittrich conceded encompassed commonly known particle sizes of flame spray powder materials.

On February 24, 1959, shortly after seeing the Sherritt Gordon announcement, Dittrich wrote V. N. Mackiw of that company an "evasive" letter of inquiry requesting samples and other information about the newly announced metal-

coated powders. In particular, he sought to know whether certain refractory oxide powders could be coated with nickel or cobalt, what size ranges could be coated and what the costs might be. Dittrich's letter concluded by stating "It is entirely possible that, with little development work, composite powders for coating could be developed which would be to our mutual benefit."[9]

As a result of his inquiry, Metco received information and samples and placed orders for a variety of coated powders to be produced by the Sherritt Gordon process upon which Mackiw had obtained a patent in September 1958.[10] See infra, p. 30. Dittrich experimented with these powders, which included aluminum coated with nickel, and concluded that the nickel-aluminum material had "many possibilities, but requires additional work." PX 33.

Dittrich reported his findings to Shepard, then manager of Metco's research and development department, in a memorandum dated December 18, 1959, entitled "Self Bonding Intermetallic Coatings for High Temperature Oxidation Resistance." Id. Therein he summarized the "well known" properties of nickel aluminide, its desirability as a coating fused to

miscellaneous base materials exposed to corrosive environments, and the prior unsuccessful work with "simple mixtures of nickel and aluminum powder" on the Climax Molybdenum problem. The memorandum detailed his procuring of special nickel-aluminum powder particles he had Sherritt Gordon prepare and the self-bonding results obtained when sprayed as composite powder. With his report Dittrich transmitted a handwritten note dated December 21, 1959, in which he stated:

> "The following ideas and properties are, I believe, completely new and useful:
>
> "(1) Starting with a composite powder, using the heat of the flame to effect alloying.
>
> "(2) Using the heat generated by an exothermic combination reaction to superheat the particles in the spray-stream.
>
> "(3) A self bonding oxidation resistant material both for primary coatings to protect base materials from oxidation, and to use as an undercoat-oxidation resistant bonding coating for ceramic thermal barrier coatings." PX 33.

Dittrich's report and discussion with Shepard led to authorization for further developmental work. On July 1, 1960, Dittrich sent Sherritt Gordon 10-1/2 pounds of "special aluminum powder" in five particle size ranges, requesting

they be coated with nickel "to give a finished powder which is the following composition by weight: aluminum 17.5% plus 1/2%/minus 1-1/2%, nickel remainder." PX 50. He advised Sherritt Gordon "that this composition is the optimum for our purpose, and we would like your advice as to whether or not you can hold the above tolerance on the aluminum content of the finished powder." Id.

Dittrich conceded that the nickel-coated aluminum powder described in Example 1 of the '515 patent (and repeated in the '248 patent) was the material received from Sherritt Gordon in response to his letter and formed the basis for the patent application filed five months later.

The Patent Office Proceedings

The parent application filed November 22, 1960 was titled "Flame Spraying Synergistic Composites." The specification pointed out that while metallic powders formed of several constituents were known in the flame spraying art, they were generally "a powder mixture" or at best "a particle aggregate." An object of the claimed invention was the spraying of heat-fusible material "in a novel form which allows the obtaining of superior results." The novel form

was "a clad composite consisting of nuclei and at least one coating layer of a different material which will synergistically act with the nuclei in the process." The purpose was to increase "the thermal efficiency of the process, aid in the bonding of the coating and/or produce results and effects by this in situ generated heat which cannot be achieved by the externally supplied heat" of the flame spray gun. The specification noted that "Bonding to the base or substrate being coated may also be aided by the synergistic action of exothermic reaction, as for example, in the case of nickel-coated aluminum powder."

Flame spraying in accordance with the invention was to be effected "in the conventional manner." Production of the clad composite powder could be accomplished "in any known or desired manner" but "preferably by the known chemical plating processes." One was described as the process of plating by ammoniacal solution — the identical process disclosed in the earlier Mackiw patent hereinafter discussed. The drawing attached to the application contains a Fig. 1 cross-sectional diagram of a grain of the novel flame spray powder which is virtually identical with Fig. 1 in the Mackiw patent drawing, except for the substitution of "aluminum" for

"metal nucleus" and of "nickel" for "metal coating."

The 1960 application presented 62 claims, some drawn to "improvements" in the flame spray process and others to a flame spray material, powder or wire. For example, Claim 51 specifically claims an

> "improvement to increase the bond which comprises spraying an intermediate layer of two components exothermically reacting with each other, forming an inter-metallic compound." PX 1.

Claim 24 describes

> "A flame spray powder in the form of individual, synergistically clad particles comprising a nucleus and at least one coating layer of a material differing from said nucleus and synergistically active with said nucleus in flame spraying." Id.

The Patent Office, perceiving the intermingling of different claims, allowed none and rejected none. Restriction was required on the ground that the claims were drawn to two separate and distinct inventions, (1) "a flame spray coating process," and (2) a powder and wire comprising "composite metal stock." PX 1.

The Patent Office action led to a succession of new

application filings with gradually changing titles but all exhibiting the same amphibolous character as between product claims and process claims. PX 2-5. The examiner again required restriction of claims in the next application filed August 16, 1961, PX 2, citing the Gutzeit patent hereinafter discussed, infra p. 35. The patentees elected to prosecute claims drawn to "composite metal stock", reserving non-elected claims for a divisional application. The elected product claims were rejected as unpatentable in view of prior art not relied on here. Reconsideration was denied despite the patentees' argument that "[t]he concept of providing individual powder particles containing a nucleus and a coated layer . . . is entirely novel to the applicants and produces superior spraying results and superior coatings . . . bonded and placed more uniformly and securely."

On Metco's appeal, however, the Patent Office Board of Appeals reversed the examiner, ruling that the patent references he relied on "do not disclose or suggest the powder of the appealed claims." In consequence, U.S. Patent 3,254,970 (not involved here) was issued to the patentees on June 7, 1966, for a "flame spray clad powder composed of a

refractory material and nickel or cobalt."[12]

The divisional application filed on October 26, 1962 included all claims except those allowed in U.S. Patent 3,254,970. PX 3. The examiner again rejected all remaining claims as unpatentable citing, among others, the Mackiw, Shwayder, Bleakley, Hensel and Montgomery patents relied on by plaintiffs here. See infra pp. 28-33. The examiner viewed those references as collectively teaching various techniques in flame spraying and the employment of particulate material, from which it would be obvious that percentages of material are a mere matter of choice. The application was marked "Abandoned." PX 3.

A further application was filed on February 10, 1964, as a continuation-in-part of the prior applications. PX 4. This application was also subjected to a restriction requirement because claims were drawn to four separate and distinct inventions, i.e., a process of flame spraying, a composite metal stock particle, a composite metal wire, and a process of applying a coating to a particular powder.

The patentees elected to proceed with a group of claims drawn to the process of producing a coated flame spray

powder. The described process, which is pertinent to the claims in suit, included a method more simple than chemical plating for cladding a nickel nucleus with finely-divided aluminum particles. It consisted of dispersing aluminum powder in a "binder" such as phenolic varnish and admixing it with a nickel powder to form the composites, which are then dried to form a free-flowing powder.

The examiner rejected all the process claims as unpatentable over Hensel and Mackiw, among other references, pointing out that the process of coating a metal powder with an adhesive and coating the substrate with another metal were techniques well known in the art. The patentees, citing 35 U.S.C. §103, filed a response arguing that the subject matter "as a whole" related to a process for producing a specific material, i.e., a flame spray powder which is self-bonding, and that "the crux of the invention resides in this choice of metals" in order to achieve the specific self-bonding result not otherwise attainable. PX 4, p. 78.

On December 23, 1966, the Board of Appeals affirmed the examiner in all respects, viewing the claims as simply "a method for coating metal powder (e.g., nickel) with a

different metal powder (e.g., aluminum)." The Grala patent, hereinafter discussed, was added as a reference "to show that aluminum and nickel are known to form a compound Ni Al with high exothermic heat development" and that it is clear from Mackiw "that composite binary coated powders are well known . . . and we find a teaching therein that aluminum powder can be coated with nickel (column 2, lines 16 and 34)." PX 4.

Prior to the Board of Appeals rejection of the 1964 process application, the patentees on March 25, 1965, filed the product application which resulted in the issuance of the '515 patent. PX 5. That application, filed as a continuation-in-part of the 1964 application, was identical with the latter in its specification of the claimed invention, including the references to "self-bonding." The restricted claims, however, relating to the flame spray material itself (product) were renumbered.

Renumbered claim 1 reads:

> "A flame spray material comprising a composite in a form suitable for flame spraying, formed of at least two metal components which exothermically react with each other when melted, forming an intermetallic compound."

The foregoing is the exact statement of claim 1 of the '515 patent except for the later addition of the following language appearing in the patent (PX 11, col. 15, lines 63-65):

> "and characterized by the ability of generating heat during flame spraying which aids in bonding to the surface being sprayed."

The genesis of the foregoing language becomes evident from the further proceedings.

After some preliminary contention over the examiner's requirement for further distinction as between process and metal stock material again intermingled in the claims as drawn, the examiner on April 15, 1966 rejected the claims now embraced in the '515 patent "for failing to particularly point out and claim the invention as required in 35 U.S.C. 112" and also as unpatentable under 35 U.S.C. §103.[13]

Metco responded to the examiner's action by making certain amendments which became the present '515 patent claims, contending that the "invention as set forth in the instant application is believed to be directed to a major breakthrough and pioneering development in the flame spray field." PX 5 at p. 71. Stressing that under 35 U.S.C. §103

the invention as a whole must be considered, including unique and unexpected properties possessed by a material, and disclaiming any intent to obtain a patent on well-known metallurgical phenomena, Metco defined the claimed invention as follows:

> "The applicants' . . . invention is limited to the concept of combining the metals which are known to react in this manner into the flame spray composite which produces the completely novel flame spray material. There is, of course, nothing in the prior art which would teach or indicate that merely because components would react in this manner that they would be useful as flame spray material or that the same should be combined in a specific form in order to make a successful self-bonding flame spray material." PX 5 at p. 76.

The examiner, stating he was unable to see "what unique and unexpected properties" the material possessed "that would make it unobvious from the art cited", adhered to his ruling.

On November 9, 1966, Metco responded to the examiner's action by making the addendum to claim 1 quoted above as indicative of "the unexpected properties which the material possesses" and which must be considered under §103. On that same date an ex parte discussion occurred between Metco's patent counsel and the examiner -- which plaintiffs

criticize — and shortly thereafter the examiner allowed the '515 patent on the flame spray powder claims.

On May 26, 1966, a further application was filed as a division of the March 1965 application ('515 patent) covering the flame spraying process claims as to which restriction had been required. PX 6. That application also survived prior rejections by the examiner and led to the issuance of the '248 patent. The first rejection came on December 11, 1967, the examiner relying on Herz, Shwayder, Bleakley, Mackiw, Bradstreet and Grala, hereinafter mentioned, in addition to other prior art. These references in the examiner's view showed it was old and obvious to apply flame spray coatings of exothermically reacting materials, to use coated component powders in the process, and to utilize a binder to form the feed materials. PX 6, pp. 65-66. Metco obtained reconsideration, contending that none of the references disclosed the flame spraying of a composite containing components which exothermically reacted to form an intermetallic compound, or taught a process capable of achieving the novel self-bonding result claimed.

When the examiner adhered to his rejection, Metco's patent counsel again obtained an ex parte interview — also

criticized by plaintiffs — and submitted an affidavit by Dittrich, sworn to June 10, 1968, stating that tests in which a mere combination of nickel powder and aluminum powder were flame sprayed onto a substrate, did not result in an adherent coating, whereas those metals did so when prepared in accordance with the process claims of the application and had the tensile bond strength stated in the affidavit. Following that conference, claim 1 was amended to state that the heat-fusible components "are distinct and unalloyed with respect to each other and . . . are present in the form and in proportion such that they react exothermically with each other." Metco emphasized "that the nature of the physical association of the two components used in this process is critical." Thereafter the process claims were allowed and the '248 patent issued.

Prior Art References

The prior art plaintiffs relied on at trial is listed in the margin.[14] Of the ten prior patents designated, only one, Haglund No. 2,943,951, was not referenced by the Patent Office in the prosecution of the patents in suit. The Bleakley, Mackiw, Herz, Grala and Shwayder patents are specifically cited in the '248 patent, and Mackiw, Herz and Grala

are also cited in the '515 patent. The Hensel, Montgomery, Bleakley, Bradstreet and Gutzeit[15] patents were specifically cited and discussed by the Patent Office in reviewing the several applications for the patents in suit.

The '515 and '248 patents are so closely interrelated as not to warrant separate discussion of the prior art as between product and process.

The earliest reference, Bleakley (1941), is titled "Method of Forming Composite Metal Structures." The examiner twice cited Bleakley, among others, in rejecting Metco's claims (PX 2, 6) on the ground it was obvious to spray two or more metals in combination. Bleakley teaches the feeding of two or more metals or other materials of different melting points separately but simultaneously into a closed melting chamber under pressure and spraying them in their mixed molten state onto the surface to be coated. The metals were fed into the chamber in "strands" of rod or wire. To obtain "a good bond" it was necessary to first prepare the surface either by using a "thermit" type flux or by heating it to bonding temperature during the spraying operation. No claim was made that the resultant coating was self-bonding.

Hensel (1945), titled "Refractory Metal Composition", discloses an improvement for "powder metal bodies" formed according to the procedures of powder metallurgy. Plaintiffs rely on Hensel to show only that the process recommended in the patents in suit for making clad or "coated" particles by coating the powder granules of one component with an adhesive (binder) and then dusting the adhesive-coated particles with another metal in powdered form was long known in the art. Even Hensel does not claim the invention of this adhesive coating technique nor does his patent relate to flame spraying.

Montgomery (1956), titled "Method of Coating a Metal Surface", relates to the formation and spraying of what are known as "cermet" flame spray materials composed of "a bonded mixture" of particles of metal and particles of a ceramic material such as a metal oxide. The cermet particles may be flame sprayed but it is done by a "powder weld" process which involves a subsequent fusion or welding step to make the coating material stick to the surface. The patent recommends that the surface "be sand-blasted before applying the coating." There is nothing in Montgomery which discloses or suggests a self-bonding material.

Mackiw (1958), heavily relied on by plaintiffs, is titled "Method of Producing Composite Metal Powders" and discloses a chemical plating process for producing "a composite metal powder comprised of at least two different metals" having different chemical and/or physical properties. As already noted, the identical drawings of the '515 and '248 patents contain a Fig. 1 cross-section of a clad particle composite of aluminum core with nickel coating that is virtually identical with a cross-section drawing of a composite nucleus and coating of two undesignated metals in Fig. 1 of Mackiw. Also, both the '515 and '248 patents describe as one method of making the "clad powders" the use of the same chemical plating process described in Mackiw.

Mackiw, however, discloses no relationship between the composite metal powders there described and the art of flame spraying. Mackiw's object, like that of Hensel, was to develop an improved process for producing composite metal powders for use particularly in powder metallurgy. While plaintiffs insist that "powder metallurgy" includes flame spraying, it is plain from Mackiw and Hensel that the term connotes the art of compacting or pressing metal powder into shapes for alloying treatment in the manufacture of metal

parts which do not lend themselves to fabrication by conventional melting and casting methods.[16] Nor is there any suggestion in Mackiw of a combination of nickel-aluminum. Both metals are merely listed in a larger group having similar properties which may be dispersed in a chemical solution in order to coalesce with metals of another group having disparate properties.

Focusing on another element of the claimed invention, plaintiffs point to the Herz and Grala patents (both 1959) as showing it was well known that nickel and aluminum "in the proper proportions and in composite form reacted together in an exothermic reaction to form the intermetallic compound, nickel aluminide."[17] Herz, titled "Sintered Ni-Al-Zr Compositions", is another patent in the field of powder metallurgy rather than flame spraying or flame spray materials. Its disclosure is directed entirely to the preparation of a nickel-aluminum alloy which would not deteriorate when formed into shapes but could retain high rupture strengh for prolonged periods at high temperatures in use. Herz found that the addition of zirconium, and heating the nickel-aluminum-zircorium powder mixture until an "exothermic reaction" began, produced a nickel aluminide plus zirconium as a homogenous

conglomerate. This material was then crushed again into powder in order to compact or cold press various shapes as desired and to give them the requisite 100% density by sintering at high temperatures.

Grala, on the other hand, while also concerned with nickel-aluminum intermetallic composition prepared by the method of powder metallurgy, sought to overcome or control the exothermic heat developed by the intermetallic reaction which had been found to weaken the resulting alloy. Grala's solution was to design a special induction furnace unit, as illustrated in the patent, and to prepare the nickel and aluminum charge not in powder or grain form but as small flat chips and fragments with the aluminum placed on top of the nickel in a crucible.

Bradstreet (1959), titled "Method and Compositions for Flame Spraying", relates to methods of overcoming the problem of "glassy coatings" when surfaces were flame sprayed with ceramic materials such as refractory oxides. Due to the brittle nature of glass, such coatings frequently failed by cracking or chipping because of the unequal thermal expansion of the underlying substrate. Bradstreet found that this

"glassy" effect could be avoided by retaining the crystalline structure of the ceramic starting materials during the flame spraying process. Bradstreet teaches that one of several ways to accomplish this is to inject finely-divided aluminum powder into the flame along with the ceramic material. As the aluminum oxidizes, i.e., burns, it raises the temperature providing additional heat to allow high melting ceramic material to reach its sintering temperature, the critical factor in the retention of the desired crystalline structure of the refractory coating. Bradstreet claims that applying any of the several methods he describes will result in the "deposit of the sintered particles as an adherent coating on said surface."[18] However, although Examples I and II of the patent refer to coatings that were "tightly adherent to the surface", no claim of self-bonding was made. Each example shows that the steel surface was "sand blasted prior to application", and in Example I also "treated with a solution of phosporic acid." And Bradstreet himself recommended that "to improve . . . the bond . . . it is desirable to roughen the surface prior to application of the coating."[19]

Shwayder (1962), titled "Process for Applying Tungsten Carbide Particles to a Workpiece Surface", was

directed to overcoming the substantial loss of expensive tungsten carbide through vaporization, oxidation or dissolution during the process of welding it to metal surfaces to harden them. Shwayder's solution was to coat the ground tungsten carbide particles with nickel or nickel-nickel phosphide as a "sacrificial material which evaporates, oxidizes and also dissolves in ferrous material", saving the tungsten carbide from a similar fate and avoiding its loss during welding.

As taught in Shwayder, the nickel coating of the tungsten carbide particles could be accomplished either by an electrolytic bath or a chemical process described in another patent. One of several methods to apply the coated particles was by flame spraying them onto the workpiece "and simultaneously flame heating both workpiece and particles." No claim was made that the coating was self-bonding.

Haglund (1960), not cited by the examiner, is offered by plaintiffs as a further prior disclosure of mixing aluminum with flame spray materials to generate additional heat by means of an exothermic reaction. The parties agree that Haglund, titled "Flame Spraying Method and Composition",

relates to the flame spraying of molybdenum disilicide. Particles of that composition are normally coated with a silicon dioxide film which prevents them from sticking together to form a "coherent" coating upon a surface when they are flame sprayed. Haglund solves this problem by the addition of metallic aluminum which exothermically reacts with the silicon dioxide during the flame spraying, thereby enhancing "the sintering together of the surface coating on the object treated."[20] The heat of the exothermic reaction overcomes the silicon dioxide coating and enables the particles of molybdenum disilicide to stick together; there is no indication it has anything to do with their sticking to the surface being sprayed.

Gutzeit (1959), on which plaintiffs most heavily rely and contend was overlooked by the examiner, but see n. 15, supra, was considered by their expert, Dr. Nicholas J. Grant, to be the most pertinent prior art reference. Entitled "Method of Flame Spraying an Alloy and the Resulting Article", Gutzeit and his related article written in 1956, n. 14, supra, according to plaintiffs, clearly anticipate the Metco patents in disclosing a flame spray material "in composite form",

namely nickel and phosphorus, which "reacts exothermically" when flame sprayed "to form the intermetallic compound nickel phosphide." They further claim that the "heat developed in this reaction" improves the adherence or bonding of the sprayed coating to the surface.[21]

There is no dispute that the Gutzeit nickel-phosphorus material is the waste metallic reaction precipitate of a chemical plating bath utilized in another industrial process,[22] although phosphorus itself is not a metal. The Gutzeit patent was directed to a method of reclaiming valuable nickel and phosphide in the spent bath. The salvaged precipitation material is dried and ground into an "alloy" powder which may be flame sprayed in a conventional manner to form a "coherent" and "adhering" nickel phosphide coating on a surface. Dr. Grant acknowledged that the Gutzeit material was unique and specialized and could only be obtained from the spent plating bath source. Nonetheless, he characterized it as a "composite" of nickel and phosphorus which formed an intermetallic compound when subjected to heat, as indicated in Gutzeit's 1956 article, and thus anticipated the claimed invention of the Metco patents.

Plaintiffs contend that the prior art "reveals every facet of the patented invention" and therefore nothing "new" has been contributed to the existing fund of knowledge as required by 35 U.S.C. §101.[23] Without doubt, as they point out, the prior patents exhibit such separate features of the invention as coated particles (Mackiw, Hensel), the simultaneous flame spraying of different melting point metals (Bleakley), the use of aluminum powder to start an exothermic reaction during flame spraying for the purpose of generating heat (Bradstreet, Haglund), and the flame spraying of a combination powder material to form an inter-metallic compound coating (Gutzeit). But to say that the presence of these features deprives the Metco powders of all patentable novelty "falls slightly short of the mark because the fact that each of its elements may be anticipated by prior art does not preclude patentability of a novel and nonobvious combination. . . . The inquiry to be made is whether the combination produces a non-obvious 'synergistic result,' in which the 'whole in some way exceeds the sum of its parts'" [emphasis in original; citations omitted]. Koppers Company, Inc. v. S & S Corrugated Paper Machinery Co., Inc., 517 F.2d 1182, 1188 (2 Cir. 1975).

The question of novelty under §§101-102 is, of course, distinct from that of obviousness under §103, a defense also strenuously [illegible]ced by plaintiffs. Burgess Cellulose Company v. Wood Flong Corporation, 431 F.2d 505, 508 (2 Cir. 1970). A resolution of those questions necessarily requires a closer comparison of the prior art and the claimed invention, and to that we now turn.

Differences Between Prior Art and Claims in Suit

Ascertaining the differences between the prior art and the claims at issue requires a precise understanding of the inventive idea the claims are said to embody. The patentees do not claim discovery of the principles of exothermic reaction or inter-metallic compound formation as between certain metals. Their patent specification acknowledges that "[a]n extremely large number of metal components are known which can be melted together in an exothermic reaction, forming an intermetallic compound with the generation of heat." PX 11, col. 3, lines 58-61. Admittedly "[a]ny of these component pairs may be utilized in accordance with the invention" provided they are suitable for flame spraying as taught in the patent. Id. And, as

Dittrich acknowledged in his research memorandum of December 18, 1959, "[t]he high temperature strength and oxidation resistance of the intermetallic compounds, nickel aluminide in particular, are well known." PX 33.

Nor do the patentees claim invention of the methods or processes by which the component metals, for example, nickel and aluminum, may be united to form clad "composite" powder granules. Mackiw (1958) unquestionably discloses one "mode of forming the clad powders" described in the '515 patent. PX 11, col. 4, lines 63-68, emphasis supplied. Indeed, it was news of Mackiw's commercially feasible method of producing coated powder particles, Dittrich testified, that spurred him to resume experimental work on the flame spray powders described in the '515 patent. PX 52, 53. The other "preferred and greatly simplified mode of forming the clad powders," the adhesive binder technique, PX 11, col. 5, lines 1-17, while apparently considered novel by Dittrich, was long ago mentioned by Hensel (1945) as the examiner repeatedly pointed out during the prosecution.

What then is the basic idea which can fairly be seen to be "new and useful," §101, and not found in the

prior art? Dittrich's own pithy statement, quoted from PX 33 supra p. 16, is difficult to improve upon. In terms of the claims in issue, he taught the flame spray art how a highly oxidation-resistant nickel aluminide coating could be made to self-bond firmly to a clean smooth substrate by the use of conventional flame spray equipment and procedures. To achieve that result, however, the starting material must be capable of generating an exothermic reaction releasing sufficient heat to superheat the particles in the spraystream so that they would bond to the surface. The only way to ensure and control such a reaction was to prepare the nickel-aluminum powder or wire in the composite form described in the patents and illustrated in the patent drawing.

Plaintiffs challenge the novelty of such claims, asserting that Dittrich simply obtained a patent on Mackiw's ready-made material or at best found a "new use" for an old material which could not be patentable.[24] The Mackiw claims, however, were of very limited nature, being directed solely to a method for chemically plating or coating particles of one metal with another so as to produce "a composite metal powder." PX 7, Mackiw. To the extent that any use of such powders was suggested, it was to form "compacts, particularly

in powder metallurgy . . . in the manufacture of special metal parts . . . [and] also in the powder metal industry." Id. and PX 52. There was no mention of flame spraying, nor of the selection of any particular metals to accomplish a given result, but merely a large enumeration of metals in groups, including nickel and aluminum, which are amenable to the Mackiw process.

Furthermore, plaintiffs' own evidence shows that the nickel-aluminum particle composites which became the patented flame spray powders in suit were the product of Dittrich's specifications, not Mackiw's. Metco, as already noted, was primarily a manufacturer of metallizing and flame spraying equipment and had been long engaged in technical research and development in that field. DX IA. While it sold powder and wire materials to users of such equipment, those materials were made by others according to Metco technical specifications, supra n. 8. The same procedure was followed in 1959-1960 when Dittrich procured specially ordered nickel-aluminum coated sample powders from Sherritt Gordon, Mackiw's employer. PX 53, 33 and 50. The contemplated use and function of these spcial powders was also Dittrich's idea, not Mackiw's. An inventor need not perfect

the embodiment of his idea with his own hands; he "may use the services, ideas and aid of others. . . ." Hobbs v. United States Atomic Energy Commission, 451 F.2d 849, 864 (5 Cir. 1971).

Mackiw's invention of a method for producing composite metal particles cannot be found to have anticipated the solution of the self-bonding problem in flame spraying to which the claims here were directed. Nor can Gutzeit's process for reclaiming and utilizing unique prereacted industrial waste be seriously viewed as such an answer. The evidence is compelling that it was Dittrich, admittedly with the aid of Mackiw's process, who taught how commercially available metal powders could be adapted for use in the ordinary flame spraying process to obtain the sought-after self-bonding coating desired by the trade.

On the evidence and compared against the prior art, the nickel-aluminum flame spray materials disclosed in the claims at issue were clearly a "new and useful . . . composition of matter" in their distinctive arrangement, function and end result, and therefore patentable under 35 U.S.C. §§101, 102.

Novelty and unquestioned utility, however, do not guarantee patentability. "A device may be new and useful and yet still not be patentable if an examination of the prior art and the ordinary skill of the artisan reveals that the new and useful innovation is obvious." Burgess Cellulose Company v. Wood Flong Corporation, supra, at 508.

The Question of Obviousness

Plaintiffs assert obviousness under 35 U.S.C. §103 as their strongest challenge to the validity of Metco's patent claims, based on a somewhat different definition of the applicable field of prior art and the level of ordinary skill of those engaged in the art. Their overall view of the prior art is virtually identical with the contention of a plaintiff accused infringer quoted in Koppers Company, Inc. v. S & S Corrugated Paper Machinery Corporation, 517 F.2d 1182, 1187-88 (2 Cir. 1975):

> "The only difference between the subject matter of [claims in suit] and the prior art is that four well-known elements have been combined in a single device wherein the elements function in the same manner as was known in the prior art and produce the same expected results."

Here, of course, the four key elements are (1) nickel-aluminum "composite" powder, (2) flame spray process, (3) exothermic reaction generating additional heat, and (4) which aids in self-bonding the resultant coating to the substrate. But unlike Koppers, supra, there is a serious dispute as to whether elements (1) and (4) appear in some form in applicable prior art which would render them obvious to one of ordinary skill in the art.

"In making the determination of 'obviousness'," the Supreme Court has only recently reminded us, "it is important to remember that the criterion is measured not in terms of what would be obvious to a layman but rather what would be obvious to 'one reasonably skilled in [the applicable] art.' Graham, supra, 383 U.S. at 37." Dann v. Johnston, ___ S.Ct. ___, 44 LW 4463 at 4466 (March 30, 1976).

Since the parties here disagree as to what is the applicable art, that question must first be resolved. Metco contends it is the art of flame spraying previously described, supra p. 5. Plaintiffs contend that flame spraying is but one of the techniques employed in the broader and presumably more learned field of powder metallurgy. Portions

of treatises in evidence tend to support plaintiffs' view. PX 72, 73. But one of them also shows that powder metallurgy as an art is a "somewhat narrow field . . . concerned with molding and sintering of powders to produce finished parts" and thus quite different from the art of flame spraying, which is concerned with the coating of metal surfaces. Some confirmation of this distinction appears from an earlier patent application of one of plaintiff Eutectic's own engineers, which referred to "The art of flame spraying." DX CS. The court finds that the art of flame spraying is of such technical complexity and industrial importance, and so sufficiently distinct from the art of powder metallurgy, as to be considered the applicable art for purposes of this case.

Whatever may be the relationship or distinction between powder metallurgy and flame spraying, there is no doubt that the level of ordinary skill applicable here is not that of the shop artisan but of the professionally trained technologist. As is evident from both the prior art and the technical qualifications of party employees who testified, the average skilled worker engaged in the engineering research and development of either field would have held degrees in metallurgy or physical chemistry and perhaps even

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advanced degrees up to the doctorate. For example, Dr. Herbert S. Ingham, Jr., manager of Metco's research and development department since he came there in 1960, holds B.S., M.S. and Ph.D. degrees in physics. Eutectic's vice-president in overall charge of research and development, Joseph F. Quaas, holds degrees in chemical engineering and chemistry and prior to coming to Eutectic in 1950 had been employed as a metallurgist and development engineer in the steel industry. While Dittrich was not the holder of academic degrees, there is no question that his early technical training in the engineering field was substantially broadened by long experience in research and development at Metco, as is evident from the paper he presented to the American Ceramic Society in 1963. PX 40.

Would it have been obvious to those so skilled that the formation and flame spraying of nickel-aluminum powders as taught in the patents in suit would produce a self-bonding coating on a metal substrate that had not been heated or otherwise treated to receive it? Dr. Grant, plaintiffs' expert, agreed that by "self-bonding" was meant a coating which would weld or alloy to the substrate in an as-sprayed condition and that a tenacious bond was one

within the range of 2,000 to 4,000 psi. There is no question that the Metco powders fulfilled these requirements. He conceded also that prior to the introduction of the Metco nickel-aluminum powders, the only known self-bonding flame spray material was molybdenum wire, of whose limitations he was aware. And he acknowledged that the Metco powders and wire were the first to be accepted as self-bonding materials which had a higher bond strength on the average than molybdenum and that they opened up new areas of use in the glass molds and aircraft industries.

Dr. Grant nonetheless was of the opinion that the composition, reaction and end result of the Metco powders was entirely "predictable" from the prior art and would have been obvious to the technically trained worker in the field of powder metallurgy. He particularly stressed the Gutzeit process patent and related article as prior teaching that a composite of powdered nickel and another element (phosphorus) would react exothermically when flame sprayed to aid in bonding the resultant coating to the substrate. And in Mackiw, he saw the very same coated composite particles that are taught in the patents in suit. In his view, it would have been a simple matter to substitute aluminum for the

phosphorus to achieve a nickel aluminide coating instead of a nickel phosphide coating. He pointed out that both Haglund and Bradstreet disclosed the use of fine aluminum particles to produce an exothermic reaction which would generate additional heat during flame spraying to aid in bonding the sprayed material. He found nothing unobvious or unexpected about the self-bonding of a coating to a substrate. The fusing or alloying of one metal with another, he testified, was simply the known metallurgical result of the application of enough heat to bring it about.

In view of Dr. Grant's undoubtedly eminent teaching and other qualifications in the field of metallurgy,[25] Metco challenged the validity of his conclusions as to obviousness by pointing out that he was admittedly a scientist, not involved with flame spraying except as an observer in connection with some of his consulting work. Dr. Grant acknowledged he has authored no writings on the subject nor has he ever had occasion to flame spray any of the materials about which he had testified. He also conceded he had no knowledge that any of the materials referred to in the prior art patents had ever been used commercially or were in fact self-bonding as he himself had defined the term.[26]

As already noted, none of the prior art patents relating to flame spraying claimed to disclose a self-bonding material in the sense of one requiring no prior preparation of the surface to be coated.[27] Dr. Grant found it necessary to read such terms as "coherent coating," "adhesion," "chemical bond," and "wetting"[28] appearing in those patents as equivalents of "self-bonding." Bleakley (1941), however, required that the aluminum powder or other "thermit" mixtures used as a flux or heating agent to bring the substrate to "bonding temperature" be applied in dry or paste form to the surface and separately ignited by the flame issuing from the nozzle of the flame spray equipment. Montgomery (1956), while referring to "an alloying reaction between the metal coating and the metal base," strongly recommended that the "substrate be sandblasted before applying the coating." Bradstreet (1959) similarly recommended that the substrate surface be "sand blasted prior to application of the flame spray coating." Gutzeit (1959) also recommended "preliminary grit blasting of the surface." Haglund (1960), which was not before the patcht examiner, was concerned only with the penetration or dissipation of a surface film of silicon dioxide interfering with the spraying of molybdenum dicilicide and is

without relevance here. Shwayder (1962) required heating of the "workpiece" (substrate) in order to accomplish the desired hard surfacing by spraying tungsten carbide.

Faced with the foregoing prior art, it is difficult to believe that one reasonably skilled in the art would have found it obvious to combine their teaching into the concept or reality of a self-bonding flame spray material as taught in the claims in suit. On the contrary, "[r]ather than serving to point the way to innovation . . . [such] teachings would tend to discourage one skilled in the art from investigating the methods ultimately used" by Dittrich to make a combination of nickel-aluminum powder self-bond to an unprepared surface. See Shaw v. E.B. & A.C. Whiting Company, 417 F.2d 1097, 1104 (2 Cir. 1969).

With greatest respect for the opinions of Dr. Grant as a scientist and teacher, the court is unable to find that a self-bonding coating can be seen in the prior art as an obvious consequence of the exothermic reaction of nickel and aluminum. Indeed, Dittrich's own early work, supra p. 14 et seq., on which plaintiffs rely as prior art, demonstrated that in practice exothermic reactions between nickel and

aluminum occur only under certain conditions, see PX 16, and that powder mixtures of those metals do not form a self-bonded coating when flame sprayed. PX 33, PX 6, pp. 89-90. Nor was it possible to form bonded nickel aluminide coatings on molybdenum steel sheet by spraying layered coatings of nickel and aluminum and applying subsequent heat treatment. PX 16, 33. These early failures cannot be attributed to lack of ordinary skill, since the work was undertaken with technical laboratory personnel of Climax Molybdenum Corporation, a leading company in the field of metals.

As Metco consistently stressed throughout the patent prosecution, the selection of the component metals and the nature of their physical association in composite form was the critical factor in producing a superior and unexpected self-bonding flame spray material. Dittrich was without doubt the first to recognize, develop and adapt the concept of coated or clad powder particles for use in flame spraying to achieve a self-bonded surface coating without prior preparation of the substrate. Contrary to plaintiffs' assertions, the result was both "synergistic" and unexpected. It was synergistic in two respects: (1) whereas nickel and aluminum powders sprayed separately or combined as a mixture

did not bond, they unfailingly did so when sprayed in the "composite" form taught by the patents; and (2) when so sprayed they formed a firmly bonded coating having greater oxidation resistance than the component metals possessed cumulatively.

That the result was unexpected is apparent from the unusual behavior of the composite particles during spraying. As Dittrich noted in his paper for the American Ceramic Society, PX 40, sprayed metal powder particles normally reached their peak temperature in the hottest part of the spray gun flame and then decreased in temperature as they traveled away from the nozzle. The patented composite powders, in contrast, did just the opposite by increasing their temperature as they traveled toward the substrate and away from the hottest zone of the combustion flame. The physical association of the component metals in "composite" form would therefore appear to be the critical factor in controlling their exothermic reaction so as to generate the necessary additional heat at the right moment to bond the coating to the surface.

That Dittrich thought Nackiw's process might be useful in the commercial preparation of such self-bonding

flame spray powders or that they now appear to be simple compositions of well known elements did not render them obvious. The court may not indulge in hindsight to determine whether an unexpected result was obvious.

> "The issue . . . is not what the patentee expected to produce but what the hypothetical person 'having ordinary skill in the art' would expect to develop if he had thought about the problem [citations omitted]. In resolving the question of obviousness, the judicial view must not include the knowledge contributed by the patentee; the teachings of his patent are irrelevant when determing what 'would have been obvious' to one skilled in the prior art before he created his 'manufacture'. [Citations omitted.]" Shaw v. E.B. & A.C. Whiting Co., 417 F.2d 1097, 1105 (2 Cir. 1969).

And as reaffirmed in Carter-Wallace, Inc. v. Otte, 474 F.2d 529, ___ (2 Cir. 1972), it is also to be "kept in mind that such things [chemical compounds] must be evaluated not alone by the degree of change but also by reference to the purpose sought to be accomplished," quoting from Schering Corp. v. Gilbert, 153 F.2d 428, 431-32 (2 Cir. 1946). That principle is equally applicable here, for metallurgy is but the chemistry of metals.

The overriding purpose sought to be accomplished by the patentees was to develop a flame spray powder that

would self-bond as sprayed, as did molybdenum wire, that would overcome the latter's disadvantages, and that would provide for sprayed coatings the superior oxidation resistance and other qualities molybdenum lacked. That this was in fact accomplished by the patented powders is shown by their immediate commercial success upon introduction to the trade. During the first full year of sale over 50,000 pounds of the Metco 404 powder were sold and eventually it replaced molybdenum wire to a large extent. Not only did the nickel-aluminum material displace molybdenum in existing flame spraying utilizations; it also opened up new areas of application where the sprayed part was to be used at elevated temperatures, as for example in the aerospace fields. While not controlling on the issue of patentability, such conspicuous commercial success in a highly technical and skilled field is a strong indication that the patented flame spray materials constituted a significant, unexpected and unobvious improvement in the art. See International Nickel Co. v. United States, 175 U.S.P.Q. 209, 213 (Ct. Cl. 1972).

On the evidence before the court — much of it of ante litem motam and documented character — the conclusion is inescapable that the flame spray materials described in

the '515 patent constituted not only a "new and useful . . . composition of matter" but also one which would not "have been obvious at the time the invention was made to a person having ordinary skill in the art." 35 U.S.C. §§101, 103.

Plaintiffs' final argument that the patents simply claim a new "use" for "old" materials is therefore unavailing. They ignore the fact that the invention is not merely a combination of familiar elements, i.e., nickel and aluminum powders. It is the manner of their relationship — the "composite" form — which produces the new and unexpected result of self-bonding and makes the combination greater than the sum of its parts. None of the prior art patents claim or disclose an equivalent result.

The situation here is not unlike that in Shaw v. E.B. & A.C. Whiting Company, supra, where the invention consisted of an artificial filament manufactured from thermoplastic polymer, a very familiar substance. Such filaments were adaptable for brush and broom bristles and could be readily produced in various shapes by passing them through an extrusion die having an orifice of the desired configuration. Shaw obtained a patent on a cruciform or Y-shaped filament

which not only gave it a high degree of stiffness and reduced production costs, but also a desirable linear orientation of the polymer molecules in the filament. Prior patentees of different shaped polymer filaments had indicated that linear orientation could not be accomplished by forming dies.

The court of Appeals in reversing the district court's contrary conclusion held that Shaw's filament was both novel and unobvious. The court noted that "[t]he district court failed to evaluate the problem posed by the prior art and appears to have relied on the proposition that, as Shaw's solution to the problem seemed a simple one, his filament was an obvious outgrowth. The simplicity of an invention or an improvement thereof is not, however, the test of its obviousness."

Painstaking review of the extensive file wrapper history of the patents in suit persuades the court that plaintiffs have done little more than repeat every argument made by a series of examiners during the patent prosecution, which eventually resulted in the issuance of the patents in suit. This included the oft-repeated argument that the invention was obvious in light of the prior art. As Metco

points out, the normal presumption of patent validity under 35 U.S.C. §282 is enhanced in such a situation. Rich Products Corp. v. Mitchell Foods, Inc., 357 F.2d 176, 181 (2 Cir. 1966); Georgia Pacific Corp. v. United States Plywood Corp., 258 F.2d 124 (2 Cir. 1958). Plaintiffs had the burden of producing clear and convincing evidence of patent invalidity and this they have failed to do.

The court finds and concludes that the invention described in the '515 patent would not be obvious to persons skilled in the art and that it taught a wholly new concept for flame spraying materials, which applied successfully — where others had failed — the principle of exothermic reaction to produce self-bonding characteristics in sprayed coatings. The '515 patent is therefore held to be valid.

In addition to the contentions already discussed, plaintiffs challenge the validity of the '248 patent on the further ground that the claims, n. 3 supra, are unpatentable as a matter of law. Relying on In re Kanter, 399 F.2d 249 (C.C.P.A. 1968), plaintiffs argue that the flame spray process referred to in Claim 1 of the '248 patent is acknowledged in the specifications to be the "conventional" process for

applying a metal coating to a surface. Plaintiffs maintain that under Kanter to support patentability, the process itself must be novel and unobvious. Any "unique" qualities of the coating, they argue, inhere in and result from the flame spray material, not the spraying process.

While the argument has surface plausibility, a close reading of Kanter makes clear that the language plaintiffs rely on was applied to a totally different situation. The invention disallowed in that case consisted of "the process of forming an adherent, silicon-containing coating ('case') on ferous metal articles." 399 F.2d at 250. Kanter's claims had been allowed by the Patent Office on the new and unobvious "product" he had discovered, namely, a silicon-containing case which did not separate from its iron or steel core as a result of spalling. As the court noted, "[Kanter] has achieved this new product by performing an old process on a starting material, or base metal alloy, not previously used in the process . . . Selection resulted in a new, useful, and unobvious product on which claims have been allowed but it did not, in our view, result in either a new or unobvious process." 399 F.2d at 251. The "starting material" referred to, however, unlike the powders here, was really the end product itself;

i.e., the patentable discovery consisted of Kanter's recognition that spalling did not occur when the core article on which the coating was formed had a stable body centered cubic crystal structure.

Here, the '248 patent in Claim 1 is directed to "the improvement [in the flame spray process] which comprises passing the heat-fusible material into said [heating] zone in the form of a composite comprising at least two distinct components unalloyed together as a single alloy and in proportion and form sufficient to exothermically react with each other at the temperature developed in the heating zone . . . ." PX 12. A "new and useful improvement" of a process is, of course, patentable. 35 U.S.C. §101. The "process" disclosed in the '248 patent is not simply the operation of a flame spray gun but the application of a coating in a manner which will cause it to self-bond as sprayed to the surface being coated.

In Application of Kuehl, 475 F.2d 658 (1958), the Court of Customs and Patent Appeals held in an analogous situation that the patentability of a process in these circumstances must, under 35 U.S.C. §103, be judged as a whole,

which includes the unobviousness of a separately patented component of the process. Id. at 663. In Kuehl a patent had been granted on a novel zeolite composition but claims directed to a hydrocarbon conversion process involving the use of the zeolite as a catalyst to crack hydrocarbons had been rejected on the ground of prior art disclosing the use of similar zeolite catalysts.

Pointing out that the novel catalyst produced a result in the claimed process that was not predictable until Kuehl had made his invention, the Court held it was error for the Examiner to require a separate showing of unexpected results from the process as distinguished from the catalyst itself. Holding that "it was not necessary to show unexpected utility in order to show unobviousness," the Court concluded:

> "[I]t is in the public interest to permit appellant to claim the process as well as the product. The result is to encourage a more detailed disclosure of the specific methods of using the novel composition he has invented in order to have support for the process claims." 475 F.2d at 666.

This is the very situation presented here.

Applying the Kuehl standard, the '248 patent was

properly granted and is held to be valid, especially when the claims were separately filed at the direction of the Patent Office. The process patent does not increase the scope of patent protection, since the patentees would under the '515 patent have the right to exclude others from making, using or selling the flame spray materials disclosed.

We now turn to the question of whether or not the plaintiffs' accused powders are in fact virtual duplicates of the nickel-aluminum compositions disclosed in the patents in suit.

Infringement

On its counterclaim for infringement, Metco had the burden of proving that plaintiffs' accused powders infringe the patents in suit. Philip A. Hunt Co. v. Mallinckrodt Chemical Works, 72 F. Supp. 865, 873-75 (E.D.N.Y. 1947), aff'd on other grounds, 177 F.2d 583 (2 Cir. 1949); Olsen v. United States Gypsum Co., 205 F. Supp. 268, 273 (E.D.N.Y. 1960); Deere & Co. v. Sperry Rand Corp., 322 F. Supp. 397, 398 (E.D. Cal. 1970).

Metco's position basically is that the burden is

met by plaintiff Eutectic's concession that its Exotec powder is substantially identical in composition with Metco's 450 powder, and the further stipulation that Exotec and plaintiff Metallizing's Moguloy M-55 are identical, that XuperBond is virtually identical with Exotec except for a small amount of undisclosed additive, and that Durotec consists of 10% of Exotec and 90% of a nickel-based self-fluxing alloy. Tr. 257, 258-61; DX CD, DX CY, p. 4.

There is no question that both Metco 450 and Exotec are composed of core particles of nickel coated with finely divided aluminum powder in a phenolic binder, and in the same proportions of approximately 5 weight percent aluminum and 95 weight percent nickel. Metco maintains that Exotec and Moguloy M-55 are made and used precisely in accordance with Example 31 found in both the '515 and '248 patents. PX 11, col. 13, PX 12, col. 13. It points to the fact that Exotec is labelled as a "Self-reacting composite powder for bond coat" and that Moguloy is described as a "Nickel-Aluminum SELF-BONDING POWDER." DX KH, DX KK.

The difficulty with Metco's position on infringement is that Example 31 calls for a materially different

composition of nickel and aluminum than the 95-5 formula employed in its 450 product and the accused powders. The standard for gauging infringement is not a product made by the patentee allegedly under the patent but the language of the claims themselves as they may fairly be interpreted by resort to clarifying descriptions found in the specifications and drawings. See Maclaren v. B.I.W. Group Inc., ___ F.2d ___ (2 Cir. 1976), slip op. 3777 at 3785-86. The four claims in issue, n. 3, supra, do not spell out specific component proportions; one must look to the specifications and examples for such information. Thus Example 31 describes a flame spray powder consisting "of approximately 15 weight percent aluminum and 85 weight percent nickel" (PX 11, col. 13, lines 74-75) — a significant difference in proportion, which goes to the very heart of Dittrich's claimed invention. Metco's own 450 powder does not conform to Example 31 proportions nor is it within the scope of the claims in issue when read in light of the specifications defining the nature of the invention.

Three of the four claims in issue — claim 4 of the '515 patent and claims 1 and 4 of the '248 patent — use the term "composite" in describing the novel flame spray

material claimed. Claim 14 of the '515 patent does not. It is that claim which Metco relates to Example 31 in contending that plaintiffs' accused powders infringe.

Claim 14 of the '515 patent, which omits the term "composite," reads as follows:

> "14. A flame spray powder in the form of individual clad particles comprising a nucleus of nickel and a coating layer of finely divided aluminum particles bound to the nucleus with a binder and characterized by the ability of generating heat during flame spraying which aids in bonding to the surface being sprayed." PX 11, col. 16.

Metco contends that plaintiffs' accused Exotec, XuperBond and Moguloy M-55 powders are produced exactly in accordance with Claim 14 to achieve the same purpose and effect set forth in the patents.[29] Since no component proportions are specified, Claim 14 read literally would cover the 95% nickel-5% aluminum accused powders.

Claim 14, however, cannot be read literally without destroying the essence of the invention claimed. The invention did not consist of pasting smaller particles of aluminum powder on larger particles of nickel powder. Indeed, the patentees were denied a patent they sought on the process

of coating one metal powder with an adhesive binder and then coating other metal particles with the sticky particles. See PX 4, pp. 69-70, 75-76. Such a coating process was old even before Hensel (1945), supra p. 29. If binding particles of different metals together with an adhesive film was all there was to the patentees' invention, Claim 14 would clearly have been anticipated and invalid. But, as already noted, and stressed by the patentees throughout the prosecution, the critical factor and essence of the invention was the pre-determined relationship between the component metals which brought about the exothermic reaction during spraying and generated surplus heat through the formation of an inter-metallic compound, thereby enabling the sprayed material to bond to the substrate.

The gist of the invention is summed up in the term "composite" as carefully defined by the patentees in the patent specification. Their definition reads as follows:

> "The term 'composite' as used herein is intended to designate a structurally integral unit and does not include a mere mixture of components which may be physically separated without any destruction of the structure. Thus, in the case of powder, the term 'composite' does not include a simple mixture of individual

> granules of the separate components, but requires that each of the individual granules contain the separate components which will exothermically react, forming intermetallic compounds." PX 11, col. 2.

Metco, in resting its infringement claim on Claim 14, would have the court read it without reference to the definition of "composite," although the three other claims in issue contain that term. While patent specifications cannot be used to expand the reach of the claims, "it is fundamental that claims are to be construed in light of the specifications and both are to be read with a view to ascertaining the invention." United States v. Adams, 383 U.S. 39, 48-49 (1966). Moreover, even though "a patentee may be his own lexicographer . . . [h]e should not be allowed to stretch his words so that they are inclusive when infringement is being considered and restricted and narrowed when validity is challenged by disclosures of the prior art." Chicago Steel Foundry Co. v. Burnside Steel Foundry Co., 132 F.2d 812, 814-15 (7 Cir. 1943).

Claim 14 of the '515 patent when read in light of the definition of "composite" and other statements of the patentees in the specifications makes it very clear that the formation of intermetallic compounds was an integral means

of generating the additional heat needed to produce the self-bonding effect. This essential element of the claimed suit simply cannot be dismissed, as Metco contends, as mere "theory of the invention."[30] The very introduction of the patents begins with the sentence "This invention relates to the flame spraying of exothermically reacting intermetallic compound forming composites." (Emphasis supplied.) PX 11, col. 1. Further on in the specifications the patents instruct that "[a]s the components, any two metallics which may be melted together to form an intermetallic compound in an exothermic reaction may be used." PX 11, col. 3, emphasis supplied. The importance of intermetallic compound formation is further apparent from the specification requirement "that the intermetallic compounds formed therefrom [i.e., the component metals] liberate the required amount of heat in the intermetallic compounds-formation and are suitable as components of a spray coating." PX 11, col. 3. Finally, the specifications note that "while the components are preferably present in the stoichiometric[31] proportions required for the formation of the intermetallic compounds, it is, however, possible to also have an excess of one or the other provided the relative amounts are sufficient to release the quantities of heat

indicated above in the formation of the intermetallic compounds." PX 11, col. 3 (emphasis supplied).

Example 1 of the patents makes clear that at least 10% by weight of the aluminum powder component is required with the balance of nickel powder to accomplish the formation of an intermetallic compound in accordance with the teachings of the patents. No lesser amount of aluminum appears anywhere in the patents and, indeed, larger proportions are specified, i.e., 15 weight percent aluminum and 85 weight percent nickel, in Example 31 upon which Metco relies to establish infringement. The claimed infringing powders, however, contain no more than 5% aluminum with the balance being largely nickel except for minor additives. This is also true of Metco's 460 nickel-aluminum powder.

Aside from patent terminology, the evidence at trial convincingly established that the formation of an intermetallic compound as a heat generating mechanism could not be accomplished when only 5% by weight of aluminum powder is used, as in the case of the accused powders. As explained by plaintiffs' expert, Dr. Grant, the constitution of binary alloys such as aluminum-nickel under varying conditions of

relative proportion and temperature has been the subject of close metallurgical study and analysis. The results have been published in widely accepted treatises, such as PX 66, and illustrated in a phase diagram relied on generally by metallurgists. PX 66-A. In order to obtain an exothermic reaction between nickel and aluminum which will produce the intermetallic compound nickel aluminide, Dr. Grant testified, it is necessary to have at least 10% aluminum in the starting material.

That proportion is not only the minimum reflected on the phase diagram, PX 66-A, but is also consistent with the proportions designated in the patents in suit and Dittrich's 1963 paper, which leaves no doubt that a bonded nickel aluminide coating was the desideratum sought by the patented invention. PX 40. As Dittrich there pointed out, "[t]he formation of the nickel aluminides from the chemical combination of nickel and aluminum is accompanied by the release of considerable heat." PX 40, p. 493. Dittrich was, of course, then speaking of the nickel-aluminum composite powder illustrated in Fig. 1 of the '515 patent — an aluminum core surrounded by a sheath of nickel — in which the aluminum content was 16 to 18% by weight as described

in Example 1. PX 11, col. 6.

When only 5% aluminum is used, Dr. Grant testified, the resulting reaction falls outside the range of intermetallic compound formation, as illustrated on the phase diagram, and heat is generated by an oxidation reaction. The patents in suit expressly distinguish the patented "composites" from "materials in which heat is generated by a reaction, such as an oxidation reaction, in which a foreign and non-metallic element is introduced . . . ." PX 11, col. 6. Although, as Dr. Grant explained, the reaction between aluminum and oxygen is also exothermic in nature, an end result is not only the generation of intense heat, up to 400,000 calories, but also the production of aluminum oxide. Dittrich, the co-patentee, corroborated Dr. Grant by agreeing that if the heat-generating mechanism is an exothermic oxidation rather than intermetallic, then it is not within the terms of the patent. Tr. 1172. His view of the nature of the invention was in accord with statements in the final '515 patent application pointing out that "proportions which will not so react [i.e., to form an intermetallic compound] are, of course, not included within the scope and terminology of the claims." PX 5, pp. 70-71.

Metco sought to avoid these patent limitations and overcome plaintiffs' evidence by attempting to show that nickel aluminide -- a compound which could only be formed by an intermetallic exothermic reaction -- was in fact present in an Exotec sprayed coating.

During trial, Metco's Dr. Ingham had flame sprayed a mild steel panel with Exotec powder, using plaintiff Eutectic's Rototec gun. The sprayed panel, DX LF, was subjected to an x-ray diffraction examination by Metco's expert, Dr. Benjamin Post.[32] The results of the x-ray scan were recorded on a stylus graph, DX LG. Interpreting the tracings on the graph, Dr. Post testified he observed the indicia of three elements in the test coating: nickel, aluminum oxide and "a distorted nickel lattice, which is definitely -- contains some reaction product." Tr. 1301. In his opinion, the reaction product was "an aluminide of nickel." Tr. 1304. That opinion lost considerable force, however, when Dr. Post later stated that the Ni_3Al composition he saw on the graph did not have "too much meaning" because the sprayed test panel did not conform to "academically approved procedure." Tr. 1305-06. Moreover, he was unable to quantify the nickel aluminide he described other than to say it was a "small

amount." Tr. 1345.

The vulnerability of such testimony became all the more apparent from an ante litem engineering report by Frank N. Longo, a Metco research engineer. PX 43. That report, copyrighted 1970 and entitled "Metallurgy of Flame Sprayed Nickel Aluminide Coatings", endeavored to supply answers to the nature of the coating structure and its bond to the coated surface. The study reported both metallographic examination of sprayed coatings and x-ray diffraction studies. With respect to the latter, Longo's conclusion was that "x-ray analysis cannot distinguish between Ni, Ni_3Al or the solid solution of aluminum in nickel." PX 43, p. 4. His ultimate conclusion was that Metco's own 95-5 powder, Metco 450, formed a relatively soft coating containing approximately 90% nickel and nickel/aluminum solid solution with only "minor percentages of non-stoichiometric nickel aluminum NiAl." The remainder of the coating contained amorphous oxides of nickel and aluminum. This was to be contrasted with the composition of the patented 404 powder in which the sprayed coating contained identifiable nickel aluminide and combined non-stoichiometric nickel-rich NiAl ranging from 70 to 90%, the remainder being oxides of nickel and aluminum. Id. at p. 7.

Metco also attempted to discredit plaintiffs' aluminum oxidation proof as being in effect a mere "theory" devised solely for purposes of this litigation. In support of that argument, Metco pointed particularly to Appendix V of the Patel report, PX 15, dated November 7, 1973, in which the author discussed experimental evidence for the "proposed Al_2O_3 theory of Ni/Al powder bonding [emphasis supplied]", as indicative of its post litem character. Other claimed admissions of plaintiff Eutectic's personnel are said to be found in Eutectic's U.S. patent No. 3,471,310 (1969), DX IY, and in a 1972 application for a patent filed by Patel and Eutectic's technical vice president, Joseph Quaas, DX CS.[33]

Eutectic's 1969 patent undeniably contains the statement that the use of a "resin type" coating on the powder particles disclosed in the patent "greatly diminishes the oxidation of such powders" as they pass through the torch flame. DX IY, col. 2, lines 36-46. But it does not prove that exothermic oxidation is not the heating mechanism. Nor does a fair reading of the 1972 patent application, in which Eutectic sought protection for its XuperBond material, prove that "prior art" 95-5 nickel-aluminum powders — presumably

referring to Metco 450 and Exotec — generated heat by means of intermetallic exothermic reaction.

At all events, whatever inferences may permissibly be drawn as to the credibility of the defending parties' position, they are unavailing unless the party having the burden of proof — here Metco — comes forward with some solid proof supporting its infringement claim. Claimed deficiencies in the plaintiffs' denial of infringement cannot be relied on to repair obvious weaknesses in Metco's case. Those weaknesses appeared in other Metco exhibits and testimony at trial. For example, DX BK and DX BL were introduced to show Eutectic's early interest in testing Metco's 450 powder, but they also tended to confirm the inability of the testing engineers to detect any nickel-aluminum intermetallic compound in the tested specimens. Again, Metco criticized Dr. Grant's reliance on the phase diagram as support for his opinion that intermetallic compounds could not be formed with only 5% aluminum in the powder. Dr. Post, however, acknowledged that the phase diagram was indeed a useful guide not only in the laboratory but in industry as well in determining whether or not an alloy could be formed and the nature of its structure. Tr. 1312. The use of this same phase diagram

was referred to by Longo in his study. PX 43, p. 1.

Such proof would be more likely to persuade a trier of the fact that the 95-5 powder composition formed a coating which was quite different from that of the 404 powder and accomplished its bond effect by a different means. In any event, it would not persuade a trier of the fact that Metco had sustained its burden of showing differently. This is especially so when Longo's study points out that metallographic examination of unetched coatings formed by Metco 450 "show none of the characteristic gray and blue colors indicative of non-stoichiometric NiAl. Microhardness verifies the absence of NiAl . . . ." PX 43, p. 4.

Nor is the balance of proof tipped in Metco's favor by Dr. Ingham's calorimetric tests which purported to demonstrate that in an atmosphere free of oxygen the plaintiffs' accused powders reacted together exothermically and not by oxidation. Such tests cannot be regarded as proof positive, however, in view of Dr. Grant's testimony that enough oxygen would be contained in the oxide layer on the nickel and in the moisture content in the heating furnace to produce an oxidation reaction equal to the reaction illustrated on Ingham's chart. Tr. 2184, 2187-88.

The shortcomings in Metco's proof of infringement are obvious. They cannot be remedied by arguing that it is the self-bonding result which matters, not the technical nature of the exothermic reaction which brings it about. Such a contention runs squarely afoul of fundamental principles recently reaffirmed in Maclaren v. B.I.W. Group, supra. While patent claims may be construed in light of the specifications, "the scope of protection granted by a patent is defined by the language of its claims rather than by its title, specifications, exhibits or by the commercial embodiments of the claimed invention." Id. at slip op. p. 3785.

The term "self bonding" is nowhere to be found in the claims in issue here and thus such a result cannot itself be the subject of a patent monopoly. The accused powders cannot be held to infringe simply because they self-bond. It was incumbent on Metco to show by a preponderance of evidence that they achieved that result "in substantially the same way" as taught by the patents. Sanitary Refrigerator Co. v. Winters, 280 U.S. 30, 42 (1929). This Metco failed to do for the reasons previously noted.[34] The accused powders are therefore held not to infringe the claims in suit.

Judgment is directed declaring that the patent claims in suit are valid as construed herein but are not infringed by plaintiffs' accused powders, and dismissing defendant's counterclaim on the merits. Submit proposed forms of judgment on notice.

SO ORDERED.

Edward R. Neaher

U. S. D. J.

Dated: Brooklyn, New York
July 1[illegible], 1976

F O O T N O T E S

1 See Eutectic Corporation v. Metco, Inc., 346 F. Supp. 846 (E.D.N.Y. 1972).

2 Both patents bear the same caption, "Flame Spraying Exothermically Reacting Intermetallic Forming Composites." Although the disclosure of the '248 patent appears to be identical with that of the '515 patent, it was required to be prosecuted by the Patent Office as an independent and distinct invention within 35 U.S.C. §121.

3 '515 Patent (PX 11)

> "4. A flame spray material comprising a composite in a form suitable for flame spraying formed of aluminum and nickel and characterized by the ability of generating heat during flame spraying which aids in bonding to the surface being sprayed.
>
> * * * * *
>
> "14. A flame spray powder in the form of individual clad particles comprising a nucleus of nickel and a coating layer of finely divided aluminum particles bound to the nucleus with a binder and characterized by the ability of generating heat during flame spraying which aids in bonding to the surface being sprayed."

'248 Patent (PX 12)

> "1. In the flame spray process in which a heat-fusible material is heated in a heating zone to at least heat-softened condition and propelled in such condition out of said zone in finely divided form onto a substrate, the

improvement which comprises passing the heat-fusible material into said zone in the form of a composite comprising at least two distinct, components unalloyed together as a single alloy and in proportion and form sufficient to exothermically react with each other at the temperature developed in the heating zone, forming an intermetallic compound.

* * * * *

"4. Improvement according to claim 1 in which one of said components is aluminum and the other nickel."

See PX 7, Prior Art Booklet, which reproduces both patents.

4 See PX 7, '515 patent, col. 2, lines 57-69, and Drawing Fig. 2.

5 Id., col. 5, lines 1-32.

6 Plaintiffs' opening statement, Tr. 20. "Tr." denotes pages of trial record.

7 In their Supplemental Notice of Reliance under 35 U.S.C. §282, dated October 16, 1973, as limited by a consent Order signed October 26, 1973, plaintiffs specified as prior art "the earlier work of the assignee Dittrich on nickel aluminum coatings to which he alluded at his deposition."

8 Metco did not itself manufacture flame spray materials but had them made by others according to its own size and other specifications.

9 Dittrich was at that time project engineer for Metco, which was then known as Metallizing Engineering Co., Inc. PX 53.

10 See PX 7, Prior Art Booklet, Mackiw.

11 Webster defines "synergist" as "2. An agent that increases the effectiveness of another agent when combined with it." Third New International Dictionary (1971) at 2320.

12 Both the Gutzeit and Bradstreet patents, hereinafter discussed, were cited in the patent as references of record. See infra pp. 32, 35.

13 The examiner held the claims

> "unpatentable over Bayer in view of Schrewelius, Herz, Grala et al., and Mackiw et al. The basic reference discloses exothermically reacting metal powders. Grala et al teaches that nickel and aluminum are exothermically reacting elements. Schrewelius teaches that it is old to add boron to flame-spray powders. Herz teaches that it is old and well known to have powder metals for flame spraying in hydride form. Mackiw et al shows that it is old to form composites of metal powders by having a metal coating covering a metal nucleus. No invention is seen in substituting nickel and aluminum or other elements known to be exothermically reactive in the composition of the basic reference. Or in adding boron a well known fluxing element or in having the metals in the form of hydrides or in employing the coated composite because all these are taught by the secondary references to be old and well known in the art and the applicants have produced no new and unobvious results." PX 5, pp. 66-67.

14	Bleakley	2,231,247	Feb. 11, 1941
	Herz	2,884,688	May 5, 1959
	Bradstreet	2,904,449	Sept. 15, 1959
	Haglund	2,943,951	July 5, 1960
	Montgomery	2,775,531	Dec. 25, 1956
	Gutzeit	2,908,589	Oct. 13, 1959
	Mackiw	2,853,403	Sept. 23, 1958
	Grala	2,910,356	Oct. 27, 1959
	Shwayder	3,049,435	Aug. 14, 1962
	Hensel	2,370,242	Feb. 27, 1945

Journal of the Electrochemical Society, Feb. 1957, pp. 104-110, "Structure of Chemically Deposited Nickel", by Gutzeit, et al.

The alleged "earlier work" of the patentee, Dittrich, on nickel-aluminum coatings referred to in Supplemental Notice of Reliance, dated October 16, 1973.

15 Plaintiffs suggest that the Gutzeit patent was cited only to support a requirement for restriction and not considered for technical content. See PX 2, p. 67. This overlooks the fact that both Gutzeit and Bradstreet appear as "References Cited By Examiner" as of record in the allowance of U.S. Patent 3,254,970 to Dittrich and Shepard. See PX 2 at p. 130. Plaintiffs' argument that the patentees made a "surreptitious attempt" to remove Gutzeit from the attention of the Patent Office (Post-Trial Brief at 19) is therefore rejected.

16 The Sherritt Gordon announcement, supra p. 14, also indicates that the Mackiw powders were primarily directed to

metallurgical procedures quite different from flame spraying, such as roll-compacting (direct production of metal strip from powder), and standard pressing and sintering techniques. PX 52.

17 Pl. Post-Trial Brief at 21.

18 PX 7, Bradstreet, cols. 8-9.

19 PX 7, Bradstreet, col. 6, lines 1-4.

20 PX 7, Haglund, col. 1, lines 55-60.

21 Pl. Post-Trial Brief at 18-19.

22 Known as the Kanigen process, in which the nickel coating of interiors of large tanks or other vessels is accomplished by a chemical reduction method. The coating bath is regenerated from time to time but eventually must be discarded due to a buildup of unwanted nickel phosphide. Gutzeit's object was to salvage the nickel and try to put it to some use.

23 35 U.S.C. §101 provides in part:

> "Whoever invents or discovers any new and useful process . . . or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor . . . ."

24 For the latter proposition, plaintiffs cite a comment of Judge Learned Hand in Old Town Ribbon & Carbon Co. v. Columbia R. C. Mfg. Co., 159 F.2d 379 (2 Cir. 1947), a case decided prior to the 1952 Patent Act which modified the old rule by allowing patentability for a "new use of a known process, composition of matter or material."

Rohm & Haas Co. v. Roberts Chemical, Inc., 245 F.2d 693, 699 (4 Cir. 1957). See also Ansul Company v. Uniroyal, Inc., 448 F.2d 872 (2 Cir. 1971); Application of Waldbaum, 457 F.2d 997, 1002-3 (C.C.P.A. 1972).

25 Dr. Nicholas J. Grant has been a professor of metallurgy and material science at the Massachusetts Institute of Technology since 1945, and since 1968 has been Director of its Center for Material Science and Engineering. He holds the degrees of B.S. in metallurgy from Carnegie Technical Institute and of Sc.D. in metallurgy from M.I.T. Prior to his teaching career he was a metallurgist for Bethlehem Steel Company and subsequently held executive positions in a research laboratory and an industrial company. Commencing in 1947 he has been retained as a consultant by some 24 leading industrial corporations, such as Corning Glass Works, Reynolds Metals Company, Kennecott Copper Company, Monsanto, Jones & Laughlin Steel Corporation, Boeing Aircraft Company, Raytheon and others, and also for the Oak Ridge National Laboratory and the Aberdeen Proving Grounds. He is also a member of some 14 government advisory groups and advisory committees concerned with technical matters. He holds 25 United States patents and numerous foreign patents, many relating to the field of powder metallurgy. He has authored over 270 publications in U.S. and foreign journals, numerous book chapters, and is co-author of "Behavior of Materials at Elevated Temperatures," M.I.T. Press, 1965. A list of professional societies of which he is a member and awards he has received are found in a more complete statement of his qualifications in evidence as PX 8.

26 To establish that such prior art materials were not in fact self-bonding, Metco noticed and conducted a series of inter partes tests (Tr. 1640-41) in which the materials were fabricated and sprayed on test panels. Plaintiffs chose not to participate in the tests but conducted cross-examination of Metco's Dr. Herbert S. Ingham, Jr., who described the tests made and offered in evidence the respective test panels. Tr. 1640, et seq., DX KA, KB, KE-1, KE-4, KE-3, KE-8, KE-6, KE-7. In view of the

controversy which arose over whether the spraying was conducted with due regard to parameters, the court did not take them into consideration in reaching its decision with respect to the validity of the patents in suit.

27 Co-patentee Shepard's prior molybdenum wire patent could not be relied upon as prior art, although it was a self-bonding material, because the self-bonding effect was entirely due to the unique characteristics of molybdenum, which, in any event, was not a metal but a refractory-type material.

28 "Wetting" is a term of art denoting the ability of melted material to penetrate a metallic surface so as to fuse or alloy with it.

29 Defendant's Post-Trial Brief, p. 2.

30 Defendant's Post-Trial Brief, pp. 13-17.

31 "Stoichiometric" is defined as "characterized by or being a chemical composition of definite proportions by weight . . . [or] a proportion of substances or energy exactly right for a specific chemical reaction with no excess of any reactant or product . . . ." Webster's Third New International Dictionary (1971) at 2248.

32 Dr. Post is Professor of Physics and Chemistry at the Polytechnic Institute of New York and holds his Ph.D. degree in chemistry from that institution (formerly Polytechnic Institute of Brooklyn). One of his major fields of interest is x-ray diffraction. He is a member and has held office in such professional associations as the American Crystallographic Association, American Physical Society, American Chemical Society and the American Association for the Advancement of Science.

Either alone or with others he has authored some 89 publications in scientific journals dealing with the structure of metallic and chemical compounds. His qualifications are more fully set forth in DX JA.

33 Defendant's Post-Trial Brief, p. 18.

34 The court has noted but rejects Metco's suggestion that former Metco employees, including Mahesh S. Patel, see DX DT, DU, who later entered the employ of plaintiff Eutectic, brought with them knowledge of the patented flame spray materials in violation of their secrecy agreements with Metco and thus paved the way for the claimed infringement. Also considered was Metco's attack upon the credibility of Dr. Grant. Even though the court did not accord great weight to Dr. Grant's views concerning the prior art, his expertise in the field of metallurgy was beyond question and the substance of his testimony far more consistent with other evidence than that of Dr. Post.

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF NEW YORK

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U.S. DISTRICT COURT E.D. N.Y.
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TIME A.M.
P.M.

EUTECTIC CORPORATION, NEW METALS CORPORATION, and METALLIZING COMPANY OF AMERICA, INC.,	:	
Plaintiffs,	:	CIVIL ACTION
v.	:	NO. 72 C 102
METCO, INC.,	:	
Defendant.	:	

JUDGMENT

This action having come on for trial before the Court, Hon. Edward R. Neaher presiding, and the issues of patent infringement and patent validity having been duly tried, and an Opinion having been duly rendered,

It is Ordered and Adjudged that:

1. This Court has jurisdiction over plaintiffs and defendant, and the subject matter of the complaint.

2. Defendant, Metco, Inc., is the owner of U. S. Letters Patent No. 3,322,515, issued on May 30, 1967, in the names of F. J. Dittrich and A. P. Shephard; and of U. S. Letters Patent No. 3,436,248, issued on April 1, 1969, to the same patentees.

3. Claims 4 and 14 of said U. S. Letters Patent No. 3,322,515, directed to a composition of a flame spray material, are valid but not infringed by the flame spray compositions made or sold by Eutectic Corporation and New Metals Corporation, which compositions are designated as Exotec, Moquloy M-55, Xuperbond and Durotec. The foregoing compositions constitute

all of the accused compositions in suit. The composition designated Moguloy M-55 is made by Eutectic Corporation and sold by defendant Metallizing Company of America, Inc.

4. Claims 1 and 4 of said U.S. Letters Patent No. 3,436,248, directed to a process of flame spraying the material disclosed in Patent No. 3,322,515, are valid but not infringed.

5. The complaint for declaratory judgment of non-infringement of the aforesaid patents is sustained, and the counterclaim is dismissed on the merits.

6. Plaintiffs are entitled to recover of defendant their costs of action.

Dated at Brooklyn, New York, this
31st day of ~~July~~ August, 1976.

Edward R. Neaher
U.S.D.J.

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF NEW YORK

----------x

EUTECTIC CORPORATION, NEW METALS CORPORATION, and METALLIZING COMPANY OF AMERICA, INC.,

Plaintiffs,

v.

METCO, INC.,

Defendant.

CIVIL ACTION
No. 72 C 102

----------x

NOTICE OF APPEAL

Notice is hereby given that Metco, Inc., defendant in the above-captioned case, hereby appeals to the United States Court of Appeals for the Second Circuit from the final judgment entered in this action on the 1st day of September, 1976.

September 30, 1976

Arnold Sprung, Esq.
Nathaniel D. Kramer, Esq.
Burgess, Dinklage & Sprung
600 Third Avenue
New York, New York 10016

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF NEW YORK

----------X

EUTECTIC CORPORATION, NEW METALS CORPORATION, and METALLIZING COMPANY OF AMERICA, INC.,

Plaintiffs,

v.

METCO, INC.,

Defendant.

----------X

Civil Action No.

72 C 102

CROSS NOTICE OF APPEAL

Notice is hereby given that EUTECTIC CORPORATION, NEW METALS COPRORATION and METALLIZING COMPANY OF AMERICA, INC., plaintiffs in the above-captioned case, hereby appeal to the United States Court of Appeals for the Second Circuit from so much of the Judgment entered in this action on August 31, 1976, as declares Claims 4 and 14 of U. S. Letters Patent No. 3,322,515 and Claims 1 and 4 of U. S. Letters Patent No. 3,436,248 valid.

John M. Calimafde, Esq.
Hopgood, Calimafde, Kalil, Blaustein & Lieberman
Attorneys for Plaintiffs
60 East 42nd Street
New York, New York 10017

October 5, 1976

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF NEW YORK

----------X

EUTECTIC CORPORATION, NEW METALS CORPORATION, and METALLIZING CO. OF AMERICA, INC.,

Plaintiffs,

-against-

METCO, INC.,

Defendant.

----------X

No. 72 CIV. 102

STIPULATION UNDER RULE 29(2) CONCERNING MISCELLANEOUS DISCOVERY INFORMATION

The parties stipulate and agree that Plaintiffs have submitted the following discovery information to defendant through informal channels:

1. Plaintiff Eutectic's answer to Interrogatory 47 should read "aluminum" in place of "cadmium" (per letter of 6/4/73).

2. Copies of both letters from M. Patel to Eugene Kalil, identified in Plaintiffs' Answer to Interrogatory 31 were sent to Harry Kapralos. The originals of these letters are in the files of Sandoe, Hopgood & Calimafde. (per letter of 6/4/73)

3. The seven-page document titled "Docket No. 222" is Eutectic's patent application on Xuper Bond Powder adverted to in Answer to Interrogatory 94. The

named inventors are Joseph Quaas and Mahesh Patel. The application was drafted by Harry Kapralos, Esq., filed on May 11, 1972 and given serial number 252,179. No office actions have been received by Eutectic and no corresponding foreign application have been filed (per letter of 11/1/73 and related telephone conversations).

4. Metco's exothermic material was tested by plaintiff Metallizing Company of America in July 1965 on a limited basis to determine the bonding properties of the material. (per letter of 11/2/73)

5. "Mogul 950" is not a code number that is used by Metallizing, nor does Metallizing have any record of using this number on any product in the past. It is the opinion of Mr. Cook that the use of this number in any document was a typographical error. (per letter 11/2/73)

6. The first demonstrations of the Moguloy M-55 powder were in February 1971. (per letter of 11/2/73)

7. Documents Bates numbered 50712-15 are the Cardex files relating to Metco products as described by Mr. Broderick during his deposition. (Letter of 11/13/73)

SANDOE HOPGOOD & CALIMAFDE
Counsel for Plaintiffs

BURGESS, DINKLAGE & SPRUNG
Counsel for Defendant

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF NEW YORK

EUTECTIC CORPORATION, NEW METALS CORPORATION, and METALLIZING COMPANY OF AMERICA, INC., Plaintiffs,	:	Civil Action No.
v.	:	72 Civ. 102 (ERN)
METCO, INC., Defendant.	:	

NOTICE OF INTER PARTES TESTING

To: Sandoe, Hopgood & Calimade
Attorneys for Plaintiffs
60 East 42nd Street
New York, New York 10017

PLEASE TAKE NOTICE that on the 13th day of November, 1973, defendant will conduct a series of tests and experiments, the subject matter of which they plan to introduce into evidence in the above-captioned case, at its main office and plant in Westbury, N. Y.

You are invited to attend.

CERTIFICATE OF SERVICE
I hereby state under Penalty of Perjury that a True Copy of the foregoing is today mailed to Counsel for the opposing party (parties).....
Date: 11/6/73 NATHANIEL D. KRAMER

METCO, INC.
By
Arnold Sprung
Burgess, Dinklage & Sprung
600 Third Avenue
New York, N. Y. 10016

Dated: November 6, 1973

INTERROGATORY 84. If the answer to Interrogatory 83 is anything other than an unqualified negative, identify each such flame spray powder manufactured and/or sold by plaintiff by its name, catalog number and any other identification used by plaintiff in connection therewith.

ANSWER: Exotec 29904, Xuper Bond, and DuroTec 19910 are exothermic composite powders manufactured and sold by plaintiffs Eutectic Corporation and New Metals Corporation. Plaintiffs manufacture and sell other types of flame spray powders but regard these other powders as not being within the scope of this litigation. Accordingly, this interrogatory and subsequent interrogatories which refer to this interrogatory are objected to, insofar as they seek the identification and additional information concerning other flame powders manufactured and/or sold by plaintiffs Eutectic Corporation and New Metals Corporation.

INTERROGATORY 85. For each and every flame spray powder identified in the answer to Interrogatory 84:

a) describe the physical form of the powder particles, giving the composition of the components;

ANSWER:

a) Exotec 29904. Nickel-aluminum composite powder, nickel core clad by aluminum powder. 4.5% aluminum and 95.5% nickel. Durotec 19910 includes 10% of the Exotec powder and 90% of a nickel-based alloy. XuperBond is essentially the same composition as the Exotec 29904 but includes an additive, the nature of which is considered to be a valuable trade secret by plaintiffs.

INTERROGATORY 85 For each and every flame spray powder identified in the answer to Interrogatory 84:

a) describe the physical form of the powder particles, giving the composition of the components;

ANSWER: (a) XuperBond is 5% aluminum powder of -325 mexh, 1.5% lead chromate powder of -325 mesh and a balance of nickel of mostly +325 mesh with minor components of between -325 to +200 mesh. Durotec is a blend of 10% of the Exotec 29904 powder and an alloy consisting of 10% chromium, 2.5% boron, 2.5% silicon 2.5% iron, and the balance nickel.

INTERROGATORY 86. For each powder identified in the answer to Interrogatory 84, set forth the dates that the same was first offered for sale and sold, and whether presently sold.

ANSWER: The Exotec 29904 powder was first offered for sale in July 1970, and was first sold in or about August 1970. The XuperBond powder was first offered for sale in August 1972, and was first sold in September 1972. All of these powders are still being sold by plaintiffs.

INTERROGATORY 94. If the answer to Interrogatory 93 is in the affirmative, identify such applications, and state the powder that the same discloses or claims.

ANSWER: XuperBond, Ser. No.

307 BAR PRESS, Inc., 132 Lafayette St., New York 10013 – 966-3906
(5824)

76-7490
76-7514

United States Court of Appeals
For the Second Circuit

EUTECTIC CORPORATION, NEW METALS CORPORATION and METALLIZING COMPANY OF AMERICA, INC.,

Plaintiffs-Appellees and Cross-Appellants,

v.

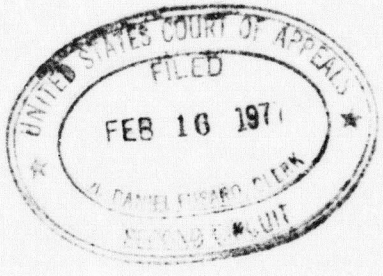
METCO, INC.,

Defendant-Appellant and Cross-Appellee.

JOINT APPENDIX

VOLUME II OF EIGHT VOLUMES

(TESTIMONY — Pages JA110 to JA438)



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PAGINATION AS IN ORIGINAL COPY

The Court is respectfully requested to disregard the underlinings, marginal notations, asterisks and other markings of plaintiffs' counsel appearing on the pages reproduced in the Joint Appendix.

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* * *

Claim 14 calls for the aluminum powder to be finely divided and to be located as a coating about the aluminum -- about the nickel. It calls for the particle to comprise a nucleus of nickel and a coating layer of finely divided aluminum particles bound to the nucleus with a binder. So claim 14 is more limited than claim four in positioning the aluminum powder about the nucleus nickel and it is also more limited in specifying that the composite is formed as an agglomerate using a binder.

* * *

Dr. Grant.

Q Dr. Grant, have you read exhibit 8, which are the qualifications of Nicholas J. Grant?

A Yes, I have.

Q Is it true and accurate in accordance with your best knowledge of the facts?

A Yes.

Q Will you describe briefly your responsibilities at M.I.T. as Professor of the Department of Metallurgy and Material Science?

A I was in the Department of Metallurgy and Material Science operate the laboratory for high temperature materials which is a rather broad activity involving many different forms of metallic and non-metallic and ceramic materials.

As Director of the Center for Material Science and Engineering I am the chief administrative and technical officer of an activity which accounts for perhaps four and a half million dollars worth of research.

My prime function is to administer the research funds and make sure that they are suitably and adequately distributed to accomplish the research program at hand.

Q And does the research work include work in the powder metallurgy field?

A Yes, very frequently.

Q Now, I see according to exhibit 8 that you also perform consulting services.

Will you describe some of your consulting services, particularly in the field of powder metallurgy?

A Well, I have consulted extensively and continue to consult extensively. For example I have now consulted continuously for the Corning Glass works for 27 years on a retainer basis.

I have had frequent occasion to be concerned with the application of powders and for the utilization and examination of failures, judgment, of applications in a fairly broad range of powder materials including for example nickel aluminum metallic compounds for the undercoating of molds and plungers which are used for hot glass pressing operations, for the coating and spraying of molds for glass manufacture.

I have been involved in Corning in the development of programs for the production of bi-flame atomization of platinum to produce platinum powders which are in turn then re-used with flame spray techniques for coating.

I have also been involved at Corning in the preparation and the evaluation of a variety of ceramic and intermetallic material such as titanium carbide and a broad spectrum of other materials with the Vesta Stainless Steel Company of Sweden.

I have also done consulting with them for 27 consecutive years. And as part of my duties there have been concerned with powder utilization extensively for electrode materials.

I have also been deeply involved in efforts with tungsten carbide and a variety of cutting and drilling materials.

And with the Reynolds Metals Company I was instrumental in helping them to establish a powder production facility. And in fact had the final judgment as to whether that facility would be put on stream or not.

This is the production of aluminum powders of what they call their particle sheet program which provides a powder for direct conversion into aluminum sheet.

I helped in the design and selection of the additional apparatus that went into the production facility.

I have consulted extensively with a second Swedish company called Efab, which developed a powder atomization technique which was used -- powders were extensively used and were sold throughout the world, and that went into sintering applications, welding rod applications, and so on.

And I currently hold the licensing rights on that powder production capability for North America and Japan. That licensing arrangement has been in turn relicensed to a Swedish company and to an American company.

I am currently a consultant for the SKC Company.

This is a small research and development organization in Hawthorne, New Jersey where their activities are exclusively in the powder and metallurgy area.

Broadly speaking they produce powders and manipulate and handle powders for just about any application that they are requested to study.

I am a consultant to the Stellite Division of the Cabot Corporation in Kokomo, Indiana.

Stellite is a major producer of harde facing powder alloys and a variety of cobalt base materials used for protective coatings.

I was consultant for many years with the Sintercast Corporation with whom -- with members of their top technical people, a series of patents had issued, which dealt with powders and specifically with composite powders which were utilized in their activities.

Then of course my own M.I.T. research activities are extensively concerned with the preparation of a vast range of powders in terms of size, shape and composition with many uses intended for them.

Q Now, sir, I see, according to exhibit 8, that you have written articles and book chapters.

Can you tell us whether any of those articles or book chapters relate to the field of powder metallurgy?

1PM2next A Yes, they did.

DDs/dl 1/2

Q I see also you have 25 U.S. patents including foreign patents.

Can you tell us whether those patents or any of those patents relate to the fielf of powder metailurgy?

A Many of them do.

Q I see you have received a number of awards.

Can you tell us whether any of these awards were made for work in the powder metallurgy field?

A Yes. I was selected as the fundamental lecturer of a metallurgy group, the MPIF trade organization in joint action with the American Institute of Mining and Metallurgical Engineers.

I have also been given the lead lecture at the Canadian American Institute of -- I am sorry, Canadian Institute of Mining and Metallurgical Engineers. This was a lead paper in their total presentation on powdered materials.

Q Now, sir, have you read the two patents in suit?

A Yes.

Q You have identified one related to the powder as 515, patent 515, and the other is 436248, which I shall refer to hereafter as the 248 patent which relates

to the method of applying powder. My question is have you read and do you understand those patents?

A Yes.

Q In your opinion, what is the field to which those patents relate?

A These patents relate to composite materials composed of two metallic components for the production of powders which are intended for flame spring with the intent of developing exothermic reaction due to the formation of an intermetallic compound.

Q In your opinion does that subject matter of these patents come within the scope of the field of powder metallurgy?

A Yes, very much so.

MR. CALIMAFOE: Your Honor, I would be very glad to have mr. Sprung conduct cross with respect of voir dire on Dr. Grant's qualifications.

MR. SPRUNG: I will wait until he is done to conduct my cross examination in my own good time.

Q As a professor at MIT and as a consultant in the field of metallurgy, in your opinion, what is the typical educational background of a person skilled in the

field of powder metallurgy?

A Typically it would be someone today who ought to have and should have at least a bachelor's degree, preferably in metallurgy or perhaps in other scientific fields. Better yet and increasingly so, it would be desirable to have either a master's or doctoral degree in order to be fully qualified to understand the complex reactions which take place, to understand the involvement of the heat processes, the various chemical reactions that can and do take place. Otherwise he is merely a technician.

Q Dr. Grant, would you describe the subject matter of patent 515 which relates to the powder as distinguished from method?

A The subject matter is that of providing a composite material, utilizing a composite material, composed of two elements which on reaction on heating will combine exothermically, that is to release heat through the formation of the intermetallic compound during the spraying process.

Q What is the form of the material described in the patent?

A It is either in powder form or in wire form.

Q What is the composite material in the context of the patent?

A Well, perhaps since the definition seems adequate I would like to use the description in the 515 patent in column 2 starting line 57 where they define the composite as used herein -- it is intended to designate a structurally integral unit and does not include a mere mixture of components which may be physically separated without any destruction of the structure. Thus in the case of powder the term composite does not include a simple mixture of individual granules as the separate component but requires that each of the individual granules contain separate components that will react exothermically forming into metallic compounds.

Further they say, line 71, in connection with powders, each grain may consist of an aggregate containing two components which will react exothermically forming the intermetallic compounds.

But preferably the individual grains of the powder are in the form of a clad composite consisting of the nucleus of one of the components and at least one coating layer of the other component.

I think this is a fair description of a composite material.

(continued on the next page.)

BY MR. CALIMAFDE:

Q Does the patent relate to any powder which is not a composite?

A No. It does not.

Q Does the 515 patent identify any of the component metals for the composite?

A Yes, it -- table 1, which was referenced earlier, shows 140 possible combinations, which is only the beginning of the possible combinations, because as I read table 1 these simply involve the systems in which the intermetallics will form, and many of these systems will have two and three and four and five intermetallic compounds which are capable of reacting exothermically, so that the ~~liftage~~ list might multiply to something of the order of 500 possible intermetallic components, and only intermetallic components -- composites, rather.

Q Is there any characteristic, Dr. Grant, which is common to the metal pairs identified in table 1 of the 515 patent?

A Yes, the expression intermetallic compound is used to identify the common features of all of these systems. This implies not just any random combinations of two elements, it calls specifically for a specific combination of two elements in sharply defined numbers -- that is

specifically it tells you the number of atoms of each of the components that must be united in order to establish an intermetallic component -- an intermetallic compound.

Q Are all of the pairs in table 1 exothermically reactable pairs?

A I presume they are. They -- in the proper combinations as they form intermetallic phases they would give off heat during reaction.

Q Now will those pairs in table 1, without regard to form or proportions of the constitutents, produce an exothermic reaction?

A No.

Q Perhaps you ought to explain, Dr. Grant, what is an exothermal reaction?

A The word exothermal means to give off heat during the reaction in contrast to endothermic, which requires that heat shall be supplied to maintain a reaction.

Q So that one can always identify an exothermal reaction by the generation of heat, which one should be able to feel, to see, to measure.

Anything which goes through a burning reaction, for example, is an exothermal reaction, so that the striking and lighting and burning of a match is an exothermal reaction. The burning of acandle is an exothermal reaction

Grant-Direct

involving the combination of carbon and oxygen, for example, to give off heat.

Now, exothermy may come about from many different sources. An exothermic reaction can be generated by the combination of two elements such as those in table 1 to form an intermetallic compound, in which case heat will be given off. It is also possible to take many of these elements and to oxidize them, combine them with oxygen, which is basically an oxidation or a burning process. This, too, will give off heat and frequently very large amounts of heat.

Q What type of exothermic reaction is the patent concerned with?

A The patent is exclusively concerned with an exothermic reaction based on a proper composition of matter such that during the reaction the material will form an intermetallic compound and give off heat in the process.

Q Then am I correct in understanding that the exothermic reaction is between the two metal components?

A Yes, sir, exclusively so.

Q Now, will you compare the oxidation exothermal reaction involving aluminum with an intermetallic exothermic reaction in terms of quantum of heat generated and any other characteristics that are of interest to us here?

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A If we take a typical case of nickel plus aluminum in the proper proportions, the atomic ratios we mentioned, if these are combined at an -- at an elevated temperature a reaction will take place in which heat will be given off. Typically the formation of a nickel-aluminum intermetallic -- a nickel aluminide, might generate something of the order of 35,000 calories. This would be our reference number, 35,000 calories of heat for what in the scientific and engineering world is referred to as a mol. A mol is a quantity of material.

By comparison if we take the same quantity of material but now involve aluminum and oxygen, not nickel-aluminum but aluminum and oxygen, under these circumstances also an exothermic reaction will be generated which will be much more violent, which will generate vastly larger quantities of heat. In fact, for this same quantity which we referred to as a mol the quantity of heat will be of the order of magnitude of 400,000 calories.

In other words, the two numbers we're comparing here for the same quantity of material is 35,000 calories in the case of nickel combining with aluminum in the proper proportions, compared to aluminum combining with oxygen at 400,000 calories, in the proper proportions. So it's almost a ten to one additional generation -- or

rather ten to one greater generation of heat from the oxidation reaction of aluminum than the intermetallic formation of the aluminide.

Sorry if I am going to fast for you.

THE COURT: Not for me. I don't know about the reporter.

Do I understand that basically, Doctor, what you are saying is that when you apply heat to this compound you get heat plus?

THE WITNESS: Yes, sir.

THE COURT: Is that what it is?

THE WITNESS: You get additional heat generated. You must --

THE COURT: A self-generated increment of heat?

THE WITNESS: Yes. You must reach a certain temperature before the reaction will begin. At that point, you will generate additional plus heat.

Q And perahps you ought to complete your answer by explaining what it is that generates the plus heat in the context of the patent?

A Oh, in the context the -- in the context of the patent the heat is generated exclusively, according to the

literature, according to the reading, by the formation of nickel and aluminum to form an intermetallic compound which would be the nickel aluminide.

Q Does the patent disclose an example for a process which utilizes the oxidation generation of heat?

A No, sir, to the contrary the patent excludes any possibility of any reaction due to oxidation. It looks at the oxidation process as being detrimental to their particular action. And in fact, this is spelled out somewhere. Column 6 -- this is in patent 515 -- column 6 lines, oh, about -- if we start reading at six, line six:

"In combining in the exothermal reaction forming the intermetallic compound, the components generate heat in situ in the actual material which is to form at least part of the coating. This is to be distinguished from flame spray processes and materials in which heat is generated by a reaction such as an oxidation reaction, in which the foreign and non-metallic element is introduced, and in which undesirable components may be produced."

So by that statement they specifically state that they do not want any oxidation effect, and in fact, in three or four other places within the patent they specifically refer to the fact that they protect the element aluminum or titanium against any oxidation reaction, judging this

again to be detrimental and undesirable.

Q Are you familiar with the heat generating reaction which takes place in the accused powder?

A Yes, I am.

Q What is the heat generating reaction that takes place in the accused powder?

A In the accused powder, which is the 95% nickel, 5% aluminal alloy, the composition is outside of the composition range in which the intermetallic can form.

On the other hand, because of the position of the fine aluminum powder on the outside of the nickel nucleus the aluminum powder is exposed to the oxidizing flame of the ox -acetylene torch, and in this case the oxygen in the flame reacts with the aluminum to generate heat due to the exothermal action of oxidation of this vastly larger quantity of heat that we referred to earlier. This heat is exclusive that of the oxidation of aluminum, since there is absolutely no evidence that there is any intermetallic formed in the accused powder.

Q Now, considering a nickel-aluminum composite, Doctor, is there a critical proportion of the nickel to aluminum to produce the intermetallic exothermal reaction?

A Yes, absolutely.

Q And what is that propoertion?

A Well, if you look at a phase diagram, one can select the specific compositions quite exactly.

MR. CALIMAFDE: May I mark Plaintiff's Exhibit 66, your Honor?

THE COURT: Certainly.

THE CLERK: Constitution of binary alloys marked for identification as Plaintiff's Exhibit 66.

(So marked.)

Q I will hand you, Doctor, Plaintiff's Exhibit 66 for identification, which at page 119 of that exhibit there is a diagram. Is that the nickel phasing diagram to which you have just referred?

A This is the nickel-aluminum phasing diagram.

Q Now, we have also prepared an enlarged version of that diagram for the Court's convenience, so that the witness can refer to parts of the diagram while he is testifying.

A May I -- may I got to the --

THE COURT: Of course, and should you wish to use the pointer, we have one somewhere.

Q I suggest you start by explaining in language we all understand, or at least us lay people here, what that diagram is intended to represent?

A When one is concerned with the structures and

ultimately the properties and behavior patterns of combinations of elements, one combines these reactions by means of what we refer to as a phasing diagram, which is what this is. And that represents a temperature plot vertically and a composition plot horizontally.

In this case the two components of interest are nickel -- I'm sorry, nickel on this side, and aluminum on this side, and so the first feature is the melting point of the pure aluminum and the melting point of the pure nickel. Then as you add nickel to the aluminum you move in that direction to see which phases and compounds form, or if you have nickel and you add aluminum gradually you can move in either direction.

Now, these then represent the melting temperatures of all of the possible combinations, and the vertical intermediate sections represent the compounds or the solid solutions which form as a result of these combinations.

Now, the combinations we're interested in are based on a composition scale here. The accused powder is a 95 nickel, 5 aluminum powder. And the -- this being an equilibrium phasing diagram tells you that that composition is not within the intermetallic field, it does not form a compound. It forms only a solution. This is no different than adding a little bit of salt to water:

You don't know from looking at it that it is that way. You can add up to 5% of aluminum to the nickel and there are no other phases formed. You still see only the single phase, which is that of a slightly alloyed nickel solid solution.

When you exceed 5 weight percent of aluminum, you get into a two-phase field, and gradually as you move across this interval, you are increasing the amount of an intermetallic nickel aluminum phase, which has the formula Ni3Al means nothing more than that it requires three atoms of nickel and one atom of aluminum to have this particular compound with its particular properties, melting point and so on.

(Continued on the next page.)

If you go further you will reach a -- a second broad field with a very high melting point, which is a different metal compound, and that intermetallic compound is the compound Ni Al, meaning that it takes one atom of nickel and one atom of aluminum to form this particular intermetallic compound. Each of these intermetallic compounds is known, if you react the nickel and aluminum in these proportions indicated by this diagram, you will form exothermically those particular compounds.

Now, the point is this: The accused 95-5 alloy is completely outside of that field, and therefore there is no basis for beliving that an intermetallic compound can form and no evidence that an important amount of the nickel-aluminum intermetallic compound does form.

Now, the compositions within the 515 patent. The lowest composition indicated anywhere is 10% of aluminum. That is the lowest indicated in the entire patent. And you see that would place you well into this two-phase field, approaching the position where you would get the maximum heat evolution, which would be approximately here at the 85 nickel 15 aluminum, which in fact is one of the preferred compositions which is in fact described in claim -- I'm sorry, in example number 31.

Q Of the 515 patent?

A 515 patent.

THE COURT: Well, may I ask this, though: I think I understand what you are so diligently trying to make clear to me: Aluminum however in some amount is requisite, is it not, to the effect to be achieved? Regardless of whether one thinks of it in terms of aluminide formation or intermetallic formation, some amount, some propertion of aluminum would be essential, or perhaps if you put it in the form of a question, would some amount of aluminum be essential to the accomplishment of the desired end result.

THE WITNESS: Up to 5% the aluminum is desired to be utilized as an oxidation reaction.

In other words, the heat that would be generated, the combination between the aluminum and the oxygen, heat is formed by the formation of the oxide, which is excluded specifically in the 515 patent.

If you get beyond the 5% and preferably to the 15% level, then the aluminum is desired to generate heat as an intermetallic compound, which is what the patent addresses itself to. So this distinction is established.

THE COURT: But what I'm trying to get at is why have even 5%, why have even that if the introduction of oxygen could accomplish this end result of heat generation?

THE WITNESS: In the -- the presence of the aluminum in the nickel in quantities up to 5% is a means of generating that pulse of heat at the time that you're spraying which permits you to raise the temperature of the sprayed material to the point where it would stick and bond.

THE COURT: Well, I will have to say that this is pretty heavy --

THE WITNESS: Yes, it is.

THE COURT: -- digestive material for me, even after lunch, but I thought I understood you to say it would be possible to generate extremely high calories with oxygen alone.

Now, we were talking there I see in terms of oxygen plus aluminum.

THE WITNESS: Yes, sir, exclusively.

THE COURT: Now, oxygen plus nickel alone, that is to say, would not accomplish this desired result.

THE WITNESS: Not nearly as effectively.

But even that is not to be discounted because these numbers which I gave earlier, namely the combination of aluminum plus oxygen to give the oxide Al 203, the heat formation of that one is of the area of minus 400,000 calories per mol of aluminum oxide. I haven't balanced the reaction. The combination of nickel plus aluminum to give the intermetallic nickel aluminide represents a heat reaction which is of the order of minus 35,000 calories, roughly one-tenth.

But in fact if only nickel were there, nickel can also react with oxygen to give nickel oxide, which has a heat effect of the order of magnitude of 55,000 calories, somewhat closer to this. But this is an oxidation reaction, which could be beneficial, yes, sir, and in fact is in some of the prior art. The two that we have, of course --

THE COURT: I under tand. But would it be accurate, correct to say that the aluminum -- the presence of the aluminum in some percentage is critical to the accompiishment of this bond --

THE WITNESS: To get this --

THE COURT: -- bonding --

THE WITNESS: To get this temperature

pulse which is effective in improving the bond.

THE COURT: All right.

Q Let me ask this question, Doctor: Is the use of aluminum with oxygen in a prior art prior to the date of this patent in suit?

A Yes, it's disclosed before 1960 in prior art.

MR. SPRUNG: Are we examining a witness or engaging in arguments now, contentions?

Q Is the patent concerned, does the patent disclose as part of the heat generating process the aluminum with oxygen reaction?

A No, it denies this as -- as an important or a desirable factor. It suggests avoiding it as -- to the extent possible.

Q Is it your testimony, Doctor, that there are two separate and distinct heat generating phenomena that occur?

A Yes, two decidedly different ones, and they occur obviously in two different compositional areas.

Q One of which is the oxidation thermal reaction?

A Yes, sir, one is the oxidation thermal reaction due to the presence of aluminum, which can occur with one, two, three, four percent aluminum, and the other is a composite material produced with aluminum as the nucleus coated with

nickel, in which you get a nickel aluminum intermetallic forming reaction, which generates heat.

In other words, the second of these reactions --

Q As a shortened label then we can refer to one heat generating process as the intermetallic generating process?

A Yes, sir.

Q And that's the Ni plus Al, nickel plus aluminum?

A Yes, sir.

Q And then the other heat generating process is the aluminum oxygen heat ~~separating~~ generating process?

A Yes, sir, separate and totally different.

Q And is it your contention that the aluminum oxygen heat generating process was known in the prior art?

A Yes, sir.

Q And it was that process which you say is disclaimed in the patent in suit?

A Yes, sir.

* * *

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Q Dr. Grant, have you had personal experience with the use of the nickel phase diagram in Plaintiff's Exhibit 66?

A Yes, I have, yes.

Q Do you know whether this phase diagram is used by people skilled in the powder metallurgical field?

A Yes, sir, that's a very accurate phase diagram which has been checked out and tested by many people. It is fully accepted within the metallurgical profession, which would include the powder metallurgist and anyone else who has ever worked with it.

I've had occasion to work with the nickel-aluminum phase diagram in many projects, and can vouch that it is quite accurate.

Q According to this diagram and according to your personal experience, in a composite containing 5 percent aluminum and 95 percent nickel, what is the heat-generating mechanism?

A In an oxydizing atmosphere the only heat-generating

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mechanism is an oxidation reaction.

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Q Your Honor, perhaps where I lost track of the

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question and where you were perhaps seeking an answer to it, I was trying to establish through this witness whether he can say as a general truism, as a result of personal experience and this diagram -- strike the personal experience, as a result of this nickel phase diagram, P. X. 66, whether when you have a ~~deposit~~ composite containing 5 percent aluminum or less, what is the nature of the heat-generating reaction in such powder, without regard to a personal examination or a personal test with respect to the accused powder, as a result of this phase diagram can he say what the nature of the heat reaction will be?

THE COURT: Can you say?

THE WITNESS: Yes, yes I can. I think I states earlier in that composition, 95-5, since there is no chance, since the phase diagram positively prohibits the formation of an intermetallic compound, therefore there can be no heat generated from the formation of the intermetallic compound. The only other heat that can form and does form, since the atmosphere in a flame spray operation is an oxidizing one, would be the oxidation of the aluminum.

* * *

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Q In the patent in suit, Dr. Grant, is there any example of a composite containing nickel and aluminum in which the aluminum exists in the proportion of 5 percent or less?

A No sir, nowhere in the patent is there any reference to anything less than 10 percent aluminum.

Q And what percentage of aluminum is necessary according to the phase diagram in order to obtain an intermetallic type reaction?

A At least 10 percent, and preferably 15 or more percent if you want to get a significant heat output, due to the formation of an intermetallic exothermic reaction.

* * *

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MR. SPRUNG: Your Honor, I object. In the first place, arguments made by counsel during prosecution of patent applications are not admissions against interest. A doctrine known as File Wrapper Estoppel will occur if a claim is amended. But there are decisions -- I think we can cite them for you, and we'll be glad to bring them up -- which show that mere arguments of counsel during prosecution do not create File Wrapper Estoppel and are not admissions.

MR. CALIMAFDE: I'm not arguing File Wrapper

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Estoppel.

MR. SPRUNG: Well, they are just not -- in other words, he wants to -- I think the file history speaks for itself, and to put a witness on the stand and pick an isolated statement out of context, put it in the record, and then start asking a witness questions along another vein, or which might seem related to that, does not create a fair record.

MR. CALIMAFDE: Your Honor, in Mr. Sprung's opening he said that they will prove copying of the patented powder, and whether it's intermetallic or whether it's oxidation makes little difference. We have now examined the witness insofar as what he understands to be the heat-generating mechanism. Concluding this part of the examination, I would like to read, as I say, just a few sentences, which Mr. Sprung wrote when he was trying to obtain this patent from the examiner.

And when the examiner told him "All of this is obvious and unpatentable," he said to the examiner very specifically certain things in regard to the heat-generating mechanism. It's a logical place for the Court to hear what the statement was. I'm

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not offering it to estop him or as a file wrapper estoppel, I'm offering it as suggested by Justice Clark in the Graham-Deer, for the Court to understand what the applicant believed his invention to be when he was pressing arguments on the examiner.

***

Q Have you read the patents and article contained in this book, Exhibit 7?

A Yes, sir.

Q Do you understand the patents and the article?

A Yes, sir.

Q Do any of the patents disclose the processes which are described in the patent 515 in suit?

A Yes, sir.

Q What are the prior patents that describe the process of forming the composite?

A The patent by Mackiw et al, 2853403.

Q What is the process disclosed in the Mackiw patent?

A It describes one of the processes described in the 515 patent,namely, the deposition of nickel onto a nucleus, in this case this nucleus is aluminum, to form a composite material by the decomposition from an pnemonical solution.

Q And are there any prior patents that disclose the process or processes of the patent in suit?

A Hensel et al, 2,170,242, which describes tungsten

and molybdenum powders which are coated with platinum, palladium and augmented with other elements.

Q What is the process disclosed in the Hensel patent, Dr. Grant?

A This is a plating operation, protective coating of rhodium, platinum or palladium, may be applied by any one of several methods such as electroplating, metal spraying, condensing of evaporated metal on the particle surfaces, chemical decomposition, and therefore it lists the same processes as are listed in the 515 patent.

Q Is the process of forming a composite affected by whether the metal components are exothermic or not exothermic?

A No. A composite is an intimate mixture of an intimate conglomeration of two components, one of which may or may not be a metal; the other one probably is a metal. In other words, you can have two metallic components, a metallic and a non-metallic component, as well, or a metallic and intermetallic component.

Q So the basis of forming the process is distinct from the nature of the metal that forms it.

A Yes. That would still be the composites by the nature of the definition.

Q Do any of the prior patents or articles in

Exhibit 7 disclose non-exothermic composites used in flame spraying?

A Yes. Bleakley does that. Bleakley describes a wire product of lead and copper, which is a composite material and is not exothermically reactive.

Montgomery describes a product of nickel plus magnesium oxide and additions of a number of elements which include nickel, cobalt, alunimum, iron and alloys, which are not -- do not form an exothermic intermetallic compound, which is produced by sintering of the product and recrushing.

Q You have used the word,sintering, once before. Perhaps for the Court's benefit and mine you what to explain what is meant by sintering.

(continued on following page)

JA 146

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A Well, sintering is a high temperature exposure of powdered material, porous material, at a temperature sufficiently high that the mass becomes slightly plastic, although you can sinter essentially to even produce a small amount of liquid faze if necessary.

What this does is tend to bond the particular components in the system, either the same or different, together, so that they now stick together and are not readily separable, so that this is a fritded or bonded, weakly bonded mass of material.

Q That is what is meant by the word sintering?

A Yes. You can sinter to any degree, but sintering begins at the point where the mass begins to stick together.

Q And I believe you testified that Montgomery discloses the process of the making of composite?

A Yes, in this case nickel plus magnesium oxide with additions of other metallic elements.

Q And does Montgomery disclose the use of the composite?

A Yes. This is the flame spraying process.

Q Any other patent in this book of prior art that disclose such material?

A Shaweder Alexander also discloses a composite for flame spraying which is not an exothermically reacting compound. This is

tungsten carbide coated with nickel, or tungsten carbide coated with nickel and nickel phosphide.

Q Would you indicate, Dr. Grant, whether the powder disclosed in the ~~Shwader~~ SHWAYDER patent was used as a flame spraying powder?

A Yes, it was used as a flame spraying powder.

Q Do any of the prior patents contained in this book, P. X. 7, disclose composites for two metal components which are capable of reacting exothermically with each other to form an intermetallic compound?

A Yes sir.

Q What are those patents?

A Herz has one of those.

This is a reaction between powdered nickel and aluminum with small additions of zirconium.

The nickel and aluminum are in the proper proportions to form the intermetallic nickel aluminide compound.

And this produce is heated and permitted to react. And specifically the highly exothermic reaction is pointed out in the patent.

Q Does the patent disclose the proportion of aluminum to nickel?

A Yes sir. In column 1 the statement is made that the usefulness of the alloy -- I am sorry -- the intermetallic

compound consists of about 68.5 nickel, 31.5 aluminum.

Q From where are you reading, doctor?

A Column 1.

Q Line what?

A Line 62, 63.

Q That line discloses the intermetallic compound NIAL. What is that? Nickel aluminide?

A That is the exact composition of the nickel aluminide composition.

Q According to this faze diagram, P.X. 66, where would a composition of this proportion lie?

A Right at the maximum point where it says NIAL.

Q Am I pointing to it (indicating)?

A Yes sir. That is roughly the middle of the intermetallic compound NIAL.

MR. CALIMAFDE: And the record should show that I am showing a composition about 68 percent --

* * *

Q Dr. Grant, before you leave this patent of Herz, can you tell us whether the Herz patent discloses the making of a composite of nickel and aluminum?

A Yes it does.

Q Does the patent disclose how such a composite is made?

A Yes it does.

Q Will you explain that please?

A Column 2 starting at perhaps at about line 18, in practice the powder particles -- these are the powder particles of aluminum nickel and zirconium for the shaped body are advantageously first produced out of a mixture of nickel powder and aluminum powder and zirconium hydrite powder which mixture is heated at an elevated temperature in which the exothermic reaction starts, which further raises the temperature of the mixture to the temperature at which the ingredients of the mixture are formed into a porous homogeneous conglomerate

containing nickel, aluminum, zirconium, in proportions corresponding to the ingredients of the mixture.

The so-called porous conglomerate is reduced to a powder by crushing and milling to a fine particle size such as minus 325 mesh. The resulting fine nickel aluminide plus zirconium powder is then formed into the desired shapes.

Q Now, will you direct your attention to line 64 in column 2 of that patent beginning with "before treating to the temperature of the exothermic reaction"?

A Well, before treating to the exothermic reaction it is good practice to compact the powder mixture of nickel, aluminum and zirconium into solid slugs of a size convenient for charging the crucible enclosure.

In practice good results are obtained by compacting the powder mixture of nickel, aluminum and zirconium hydrite particles into slugs about 2 inches in diameter and 2 inches high for a density of about 3 grams per cc..

Q Now, there, Dr. Grant, is he disclosing a process for making a composite of the nickel and aluminum?

A Yes, he is.

Q He calls for compacting. Can you explain for our benefit what is meant by a compacting of this powder? Can that be interpreted literally?

A Compacting in this case would demand that a very intimate

6a

Grant-direct

contact be obtained between the powders which are put together, namely, the nickel, aluminum and zirconium.

(Continued on next page.)

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3pm R3

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Q At this point in the process the powders are not alloyed?

A No, sir. When they are compacted they are present in an intimately compacted form in contact with each other. They are not alloyed, no, sir.

Q Then would you explain to us what he does with that compacted powder?

A The compacted powder is then heated to a temperature such as to ignite the powders to start the reaction to form the single aluminide product.

Q Is that an exothermic reaction?

A Yes, sir. In column 3 at about line 33 it says, Depending on the amount of the metal powder charge a longer or shorter time is required to bring the powder mixture charge of the crucible to the reaction temperature between 800 degrees centigrade and 1200 degrees centigrade. The exothermic reaction raises the temperature of the heated powder mixture to a higher temperature such as 1650 degrees centigrade.

Q And in this patent I see that Herz uses the expression intermetallic compounds?

A Yes, sir.

Q Is it being used there in the same sense that you have been using the expression intermetallic compounds

describing the nickel aluminide in the text of PX66?

A Exactly.

Q Is that an expression that is known to people skilled in the art, the expression intermetallic compound?

A Yes, sir.

Q Are there any other patents that disclose the composites having two metal components which are exothermically reacted to form intermetallic compounds?

A Yes, sir. The ~~Cutsite~~ GUTZEIT patent, coupled with the article which ~~Cutsite~~ GUTZEIT is an author, the article entitled, Structure of Chemically Deposited Nickel, which ~~Cutsite~~ GUTZEIT is an author, which was published in 1957 as part of that same system, and here we discuss the system nickel phosphorus which on heating leads to the formation exothermically of nickel phosphide Ni_3P, which is accompanied as described in the article with the generation of a large amount of heat.

Q Are there any other patents?

A No, sir.

Q All right, so that so far you have discussed those patents which disclose composites of non-exothermic metals, and you have then discussed those patents which disclose deposits of two metal components which do react exothermically to produce intermetallic compounds.

Now can you tell us whether any of the prior patents disclose composites having aluminum as a component

for reacting exothermically with the oxygen during flame spraying?

Is that question clear, Dr. Grant?

A Yes, sir.

Q I want specifically to go to that heat generating mechanism between aluminum and oxygen.

Are there any patents which disclose that?

A One such patent is Bradstreet which discusses oxides which are mixed with aluminum, nickel, cobalt, silicon, chromium metals, and some of their compounds, and in which the aluminum is reacted with oxygen to give an increment of temperature during flame spraying which enhances the bonding of the product to the substrata.

Another one would be the Haglund patent which discusses a combination of molybdenum disilicide with aluminum and perhaps other oxides in a binder phase in which aluminum reacts exothermically with oxygen to increase the temperature of the system for the benefit of bonding.

(continued next page)

Q Do either or both of those patents disclose the use of aluminum for the purpose of increasing the temperature of the particle that is flame sprayed?

A Yes, sir. They both do.

Q Do any of the prior patents in PX 7 disclose a composite specifically of nickel and aluminum?

A Yes. Again, the earlier mentioned patent of Herz specifically discusses the compound of nickel -- intermetallic compounds of nickel and aluminum.

Grala also discusses composites of nickel and aluminum.

And Mackiw also discusses composites of nickel and aluminum in compositions which would give the aluminide.

Q Does the Mackiw patent disclose a use for the composite particle?

A Yes. It discloses broad general use of his composite material in the entire powder metallurgy industry.

Q In your opinion, does flame spraying come within the scope of powder metallurgy?

A Yes, sir.

Q Does Mackiw disclose any size for the composite particle?

A Yes. It discloses a size range of from one to two hundred microns.

Q Do you know whether that size is suitable for use in flame spraying?

A Yes, sir.

Q What is the typical size for flame spraying?

A For flame spraying it could be minus 325 mesh which is less than 44 microns. For other applications it would be in the range perhaps of minus 140 mesh and on -- I am sorry -- minus 140 microns -- and on 10 microns -- and this would be encompassed within a range of the powder size that Mackiw was making.

Q Does Mackiw disclose anything with regard to the portion of the metals forming the composite?

A He discloses the need for producing materials based on atomic ratios, therefore ratios which would lead to the formation of intermetallic compounds.

Q May I direct your attention to Column 3 of the Mackiw patent beginning at line 6 reading, "The desired ratio"?

A I am sorry. Did you say Column --

Q Column 3 of the Mackiw patent.

A What line, please?

Q Line 6. It is the new paragraph , "The desired ratio --"

A The desired ratio of the respective metals in the

desired composite metal can be obtained very easily.

Q Now, what is he talking about there, Doctor?

A Well, basically that he could produce by his technique compositions that would vary literally over any extended range that he would desire to produce. And this would include intermetallic compounds. But it did not have to include the intermetallic compounds. The flexibility of his process was such that he could obtain almost any composition.

Q Is there anything in the disclosure of the Mackiw patent that would discourage a powder metallurgist from considering the Mackiw composite for use in flame spraying?

A No, to the contrary, it should be very attractive.

Q Can you tell us why? Can you explain or expound on that answer?

A The process that was utilized by Mackiw permitted one to select a low melting point metal. If we take the case of aluminum and nickel it permitted one to take the aluminum and use it as the nucleus and build onto this nucleus a nickel layer of any desired thickness such that the aluminum would be protected from oxidation, so that if one wanted to utilize an intermetallic compound formation one would have the protection of the aluminum against oxygen

from the flame.

A second advantage would be that these particles would tend to be quite uniform in size and shape and therefore would be ideally suited for spraying operations since a size range or a shape change is undesirable in spraying operations.

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Q Is there anything in the Herz patent that would discourage a skilled engineer from applying the idea of using nickel aluminum powder in flame spraying?

A No, sir.

Q Dr. Grant, do any of the prior art patents, and including the article in answering the question, in other words, the patent and the article contained in our book, PX7, disclose a composite for flame spraying of two metal components which exothermically react to produce a metallic compound?

A I am sorry. Would you repeat that?

Q Certainly. Do any of the patents or the article in PX7 disclose a composite for flame spraying of Two few metal components which exothermically react to produce an intermetallic compound?

A Yes, sir.

Q What are those patents?

A Gutzeit suggests for flame spraying a composite composed of nickel and phosphorus which on reaction exothermically forms an intermetallic compound.

Herz describes a nickel and aluminum composite which forms an intermetallic compound through an exothermic reaction.

Grala --

Q Now, Doctor, my question included the limitation of a product for flame spray.

Does the Herz disclose this composite for flame spraying?

A No, sir.

Q So we are limited to Gutzeit? Am I correct?

A Right.

Q Now, would you compare the Gutzeit powder with the powder of the patent disclosed in patent 515?

A Outside of the fact that one is based on the formation of the intermetallic compound NiAl or NI_3Al, the Gutzeit patent, plus the article, in every way described the procedure for doing exactly the same thing with NI_3P such that a coherent coating which adheres well is produced in a flame spray operation.

Q Now, if one desired a nickel aluminide instead of a nickel phosphide as disclosed in Gutzeit, what would be required?

A Simple availability and substitution of an NI_3P type forming intermetallic composite material.

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Q And is that composite disclosed in any of the prior art patents in P.X. 7?

A Yes, it's disclosed in the ~~Gutzite~~ GUTZEIT patent and article.

Q No, the substitution of the nickel-aluminum composite for the nickel-phosphorous material in ~~Gutzite?~~ GUTZEIT

A Yes, that's in the 515 patent.

Q No, my question is is there any prior art which discloses a nickel-aluminum composite which in your opinion can be substituted for the nickel-phosphorous composite of Gutzite?

A That would be the -- the ~~Mackiew~~ MACKIW NiAl composite material.

Q Now, is there anything in the ~~Mackiew~~ MACKIW patent to discourage the substitution of nickel-aluminum composite for the nickel-phosphorous composite disclosed in Gutzite?

A No sir.

* * *

Q Dr. Grant, before the recess I put to you the question whether any of the prior patents disclosed a composite for flame spraying, and then I used the expression of two metal

components which exothermically react, and so forth, and you mentioned ~~Gutzite~~. GUTZEIT Now, ~~Gutzite~~ GUTZEIT discloses nickel and phosphorous. Is phosphorous a metal?

A No.

Q Now, what was the basis of your answer?

A Well, I missed the expression of "two metals" and was concentrating on the expression "intermetallic for the formation of". For the formation of an intermetallic you do not need two metals. You can have a metal and a non-metal, or a metal and a semi-metal, the point being that if the two elements involved have the proper characteristics they will react to form an intermetallic compound.

The second component of this system could be a metallic such as aluminum, a non-metallic such as silicon or phosphorous, or tellurium, or sulfur, and that wouldn't make any difference. So that my response was really on the formation of the intermetallic and I simply missed the aspect of two metals to do this, so -- which happens to be the case with nickel and aluminum, nickel and titanium, nickel and tantalum.

But I was covering the more general case in which the intermetallic is formed with whether a metal or a non-metal.

Q Is tellurium indicated by the symbol Te, is that tellurium?

A Yes sir.

Q Is tellurium a metal?

A It's a semi-metal. It has some -- it has some aspects of metallic structures and some which are not.

Q How do you compare tellurium in those terms with phosphorous, for example?

A Tellurium is more metallic than phosphorous, for example.

Q And boron is another material I'd like to ask you about. Is boron a metal?

A No, boron is not a metal. Silicon is also not a metal.

Q Do you know, Dr. Grant, whether silicon is mentioned in the Table 1?

A Yes sir.

Q Do you know whether tellurium is mentioned in Table 1 in the patent in suit?

A Yes sir.

Q Well, is it your testimony that Table 1 includes pairs one of which is not a metal?

A Yes sir.

Q In flame sprays what is required for the coating to adhere to the base metal?

A For a coating to adhere it has to be alloyed to the base metals; in other words, there must be a -- in the language, a wetting action, the one must be capable of wetting the other face, which then leads to alloying or bonding, in which case

then the coating could be described as self-bonding.

Q Does the patent in suit --

THE COURT: Did you say wetting or wedding?

THE WITNESS: No, w-e-t-t, although the other choice is not a bad one.

Q Does the patent in suit 515 disclose the bonding characteristics of the sprayed coating?

A Excuse me?

Q Does the patent 515 disclose bonding characteristics for the sprayed coating?

A Yes sir.

Q And how is that characterized by the patent in suit, the bonding characteristic?

A I'm sorry?

Q What is the nature of the bonding as disclosed in the patent in suit between the coating and the base metal?

A There is -- there is alloying, which can take place during the flame spraying action, which would give alloying, and therefore self-bonding.

Q And what according to the patent produces the alloying?

A In this case it requires a sufficiently high temperature so that the material will be either highly plastic or liquid, and so that a diffusion action can occur and one element can

diffuse into the other to establish an alloy bond.

Q Prior to November 1960, which is the filing date of the first filed application, were conditions known which caused the alloying of the sprayed coating and the base metal?

A Yes sir.

Q Do any of the prior patents disclose those conditions?

A Yes sir.

Q What are they?

A The Bradstreet patent discloses a reaction in which the presence of the aluminum increases the temperature of the particles in the flame by an oxidation reaction, which leads to a good bond which is both mechanical and chemical, and for example, example 3 discusses good adhesion.

Q Are you referring to the Bradstreet patent, Dr. Grant?

A Yes sir.

The ~~Gutzite~~ GUTZEIT patent discloses a coherent coat which adheres and in fact describes a salt spray test in which the sample lasted for 300 hours, which obviously would have to indicate that that was a very excellent bond, and certainly not a mechanical bond.

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Q May I return you for a moment to the Bradstreet Patent, and particularly column six.

THE COURT: Which one is that?

MR. CALIMAFDE: Bradstreet, your Honor.

Q Column six, beginning with about line seven:

"One of the advantages of the coating." Do you see that, Dr. Grant?

A Yes, sir.

"One of the advantages of the coatings of the present investion is that they are considerably more efficient in the utilization of the heat of the flame than other types of flame spraying systems. Since the particles are in discrete form, they need only be surface-heated to the extent of having the particles bond together by sinter action, rather than utilizing a considerable amount of the heat of the flame in melting a solid rod of the material and spraying it as a molten mass onto the surface to be covered.

"In operating the process of the present invention, the particles should reach the surface to be coated at their highest temperature."

Q And what is the significance of that?

A The significance here is that by raising the temperature of the system to the point where it is liquid, for example, it guarantees that the opportunities for bonding are

improved that much.

Starting at line 25, column six, "One of the other outstanding advantages of the process of the present invention resides in the fact that the articles to be coated need not be heated prior to the application of the coating."

Q Are there any other patents which in your opinion disclose the conditions for producing alloy in between the coating and the base metal?

A The Montgomery Patent. For that, if we look at column five, lines 12 to the end of that paragraph, it states, "The coating is accompanied without undue heating of the target, the metal part being coated. The temperature attained by the target is controlled by the distance from the gun to the target. Just enough heat is used to alloy a given coating to a given metal base."

Q And now will you direct your attention to column two of the same patent, the Montgomery Patent. At line 63, column two, beginning with, "The greater the degree of wetting."

A "The greater the degree of wetting or agglomeration there is, the greater is the usefulness of the combination, provided the combination will also alloy with the metal to be coated, and is sufficiently refractory to give -- refractory for a given surface."

Q Is the something there referring to the combination between the alloy and the base metal?

A Yes, sir.

Q Now, Dr. Grant, assuming that prior to November, 1960, it was desired to make a self-bonding powder for flame-spraying, did the literature explain to one skilled in the art how to make such a powder?

A Yes, it did.

Q Will you explain your answer, please?

A The literature specifically states that during the flame-spraying operation there must be a temperature increment which will raise the temperature of the powders to the point where they are tacky or sticky or molten, so that on reaching the substrate, if the substrate is adequantely clean, bonding or alloying will be accomplished and a self-bonded structure results. This heat increment can come about either from a rise in temperature of the powders due to the formation of an inter-metallic exothermic compound reaction, or from the generation of heat by an oxidation reaction such as has been described in the patents we have just discussed."

Q And now assuming again, Dr. Grant, that prior to November, 1960, a person skilled in the art was seeking a nickel-aluminide sprayed coating, does the literature explain how to make a powder that could be be used in flame-spraying?

A Yes, sir.

Q Would you tell us?

A Yes, sir. Yes, the maskiw-composite powder would be an excellent example of this. And that, coupled with the exothermic reactions described in the Herz Patent, and also in the Grala Patent would clearly indicate the exothermic generating reaction to go along with that powder.

Q Now, is there any relationship between the physical closeness of the two components in a composite whether they be metal, or metal and non-metal? Is there any relationship between the physical closeness of those components and the inter-metallic exothermic reaction?

A Yes, sir, there would have to be. One could assume two discrete sets of individual particles, and if they, in spraying, did not contact each other, there would be no exothermic inter-metallic reaction formed.

This obviously implies that the particles must be in close contact with each other so that at the right temperature they will begin to react exothermically, inter-metallically to increase and generate this heat. So that closeness of contact, the intimacy of contact is a critical part of the -- of the heat-generating exothermic reaction in the case of the inter-metallic phase.

Q Did knowledge of that relationship exist in the

prior art?

A Yes, sir.

Q By the prior art, I am referring to the art in our PX-7?

A Yes, sir.

Q In which patent, Dr. Grant?

A Montgomery again, column two, lines -- starting with line 62.

He says, "The usefulness also varies with the temperatures to which the coating is subjected and used. The greater the degree of wetting or agglomeration," which means the closeness of these, "the greater the usefulness of the combination."

And I think, again, column one, line 63: "The mixture of nickel and magnesia can be pressed into compacts or briquettes and sintered to agglomerate and sinter-bond the components by a wetting reaction."

And again, this indicates to me -- That is, the pressing and agglomeration, indicates the need for close, intimate contact in order for those reactions to take place.

Q Is there any relationship between the powder being in composite form and self-bonding?

A Yes, sir.

Q What is that relationship?

A If the composite is truly a composite in terms of having the two components directly in contact with each other, one enhances the possibility for getting the intermetallic reaction, and therefore the heat-generation.

Q And is it the heat-generation that's required for self-bonding?

A Yes, sir. The exothermic reaction is necessary.

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Q Was that knowledge known to prior art?

A Yes, sir.

Q Now, have you examined the accused powder identified as Exotec?

A Yes, I have.

Q Is that powder a composite, as that word is defined in the patent?

A No, sir.

Q On what do you base your answer?

A Well, I obtained --

THE COURT: When you say as defined in the patent, may I assume we are talking about 515?

MR. CALIMAFDE: Yes, sir. Thank you, your Honor.

THE WITNESS: I obtained samples of the powder, and had them -- and examined them in a scanning electron microscope, which permits a very, very high magnification of the particles, so that they can be examined without polishing. Subsequently then, we sectioned these particles and examined them in cross section so that we could see not only the surface, but so that we could see through the entire cross section as to what the nature of the distribution of the nickel nucleus and the fine

aluminum particles were, relative to that nickel nucleus.

* * *

Q I will hand you the Exhibits 14, 14A and B. I have already asked whether you could identify them and you have identified them?

A Yes, sir.

Q And now will you describe for the Court, taking them seriatum, please --

A The X14 shows two different magnifications, namely the magnification of 200 in the upper view and the thousandth magnifications in the lower view.

Q Is that what the X means, it means times?

A 200 times, yes, sir.

THE COURT: In other words, 14 is really two views?

THE WITNESS: Yes, the upper one is marked

200 X and the lower one is a 1,000 X.

THE COURT: I see.

THE WITNESS: And it shows the nature and distribution of the fine aluminum particles around the nickel matrix, nickel nucleus. The only problem is that you are only seeing predominantly the aluminum in this case, and you can see that there are large pieces of aluminum projecting on the outside, and therefore exceedingly poorly incorporated or bonded to the particular particles.

14A is the Metco 450 alloy --

Q Dr. Grant, before you leave this first one --

A Yes, sir?

Q (Continuing)-- PX 14, you -- will you explain what is shown in this photograph? I see things that look like, oh, little nuts, perhaps, little miniature walnuts.

A Well, the -- the granular particles, which are about 70 microns in diameter, have a nickel nucleus internally, and what we are seeing then, is some of the aluminum particles imbedded in a cement around that nickel nucleus, so that you are seeing very little of the nickel nucleus, and you are seeing predominantly aluminum particles with -- some of them, some of the aluminum particles sticking well out of the system, in other words, not at all well incorporated into

the coating.

Q How do you distinguish between the aluminum and nickel?

A By the way they react or behave in the electron beam in the scanning electron microscope.

Since the aluminum has an oxide on it, it responds by fluorescing in a very characteristic way, compared to a more metallic nickel. So it's very easy to tell the two apart.

Q Is the aluminum what is light-colored and what seems to be ball-shaped; or is that the nickel?

A No, there is aluminum on the ball-shaped area, too, but you see large particles of aluminum which are the lighter-colored ones, more prominently.

MR. KALIL: Can you see it in your photograph or in your Xerox of the photograph?

THE COURT: Well, it isn't too bad. I suppose I can say from the description, I presume that what I am seeing --

THE WITNESS: Would you like this?

THE COURT: All right.

(Continuing)--that these --

MR. CALIMAFDE: Why don't you put your pencil on what is supposed to be aluminum and what is supposed to be nickel?

Grant - direct

DDS 5/1

(The witness continued to indicate.)

THE WITNESS: These are the 70 micron particles with some aluminum particles around the outside.

These, the very large ones, are a large portion of the aluminum, and you see them here, too, and you see how they are sticking out into space, literally (indicating).

Now, the Metco 450, which is the 14A, is not extremely different. It is indeed a fairly similar looking product to the Utetco alloy.

What is different is what you see in 14B, which is the Metco 404, namely, the 80 nickel 20 aluminum alloy.

That is the product which is so well described in the Patent 515, in which you can see the darker internal portion which is the aluminum and a distinct continuous coating of nickel around each of the aluminum particles.

So in this respect the two products do not look at all alike, namely, the ED-20 composition, which is the intermetallic forming composite, and the 95/5, which I have said is

not the intermetallic-forming product.

MR. CALIMAFDE: Your Honor, in order that there be no misunderstanding in regard to plaintiff's contentions, it is the plaintiff's contention that the Metco 404 is the patented powder, but that the Metco 450 is not.

* * *

Q Dr. Grant, have you performed any tests to determine the reaction of the aluminum in the accused powder?

A Yes, I have.

* * *

Q Can you identify these?

A Yes, sir. These were calorimetric tests. And calorimetric in this case refers to the entity calorie which is a unit of heat, and therefore a calorimetric test is a measurement of the heat which is either liberated or used in the course of a heating operation associated with any reactions which might take place as a result of that heating operation.

What we did was to take small amounts of the Metco 8020 alloy, which is the Metco 404, and subjected this to heating in the calorimeter, and measured the nature of the temperature change in air in order to establish what these temperature effects might be.

And we have on these charts curves. The curves are of two different sensitivities in terms of scale. And we need only look at my chart, which is the red one, the one completely shown --

Q What exhibit number is that, Doctor?

A That is 65.

Q It should be on the yellow sticker.

A Yes, 65, right.

Now, to demonstrate that this apparatus is

accurate and it does know what it is doing, if you look at the lowest scale there where the curve dips for the first time, and that i the point at which the endothermic reaction occurs, namely, that is a melting reaction, that is exactly the temperature at which pure aluminum melts, namely, 660 degrees Centigrade.

So this instrument has detected very accurately the initiation of melting of the aluminum, and the size of the dip is therefore a measure of the amount of heat which is consumed -- heat had to be added -- in order to melt the aluminum.

When the aluminum became molten there was a rapid temperature rise, which reaches maximum point near 800 degrees Centigrade, and then, having reached the peak, the curve dips, but stays at a high level compared with initial condition, namely about 15 degrees above the original position.

(Continued on the next page.)

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A Now, I won't say any more for the moment about that curve.

But let's turn our attention instead to PX 64, which is for the Eutectic 95/5 alloy, also run in air, same amount of material under the same circumstances, and now we have again a red and green curve with two different scales.

And again, at 660 degrees centigrade, we notice that there is evidence of the melting of aluminum -- now remember in this case, the aluminum is on the outside of the nickel, rather than on the inside, as it was in the previous case -- and in this case, the aluminum is outside, and you will note that after melting, the peak in temperature is reached very, very much more rapidly. It is reached not at 800 degrees centigrate, as in the previous case, but at 700 degrees.

Furthermore, after reaching this peak, there is a decay in temperature, which brings the temperature back down to the previous level. In other words, the heat pulse curved very sharply and then faded out completely, so that the curve returns to its old position in distinction of the high level which is maintained in the METCO 404 material,

* * *

THE WITNESS: Yes, red is five, green is two in Exhibit 65.

And red is 10 and green is 2 in Exhibit 64.

Those scales are there.

Now, these temperature pulses, if I may add, then relate themselves back to Exhibits 14 -- Exhibit 14 goes with Exhibit 64. Right?

And Exhibit 65 goes with Exhibit 14-B.

These are the powders which are involved in both of these cases.

Do you have that?

THE COURT: Yes.

THE WITNESS: Am I going too fast?

THE COURT: I have it.

THE WITNESS: Now, if we look at Exhibit 65 and compare it to 64, and that is characteristic of slower reaction involving a smaller amount of heat.

MR. CALIMAFDE: May I be permitted to aid, your Honor?

THE WITNESS: In other words, it requires a longer period of time in terms of the temperatum

to reach a peak. Having reached a peak, the peak doesn't decay completely but, in other words, the temperature generating action continues because it maintains the temperature that powder mass 15 degrees above the base line.

BY MR. CALIMAFDE:

Q The base line being this (indicating)?

A The original base line.

Now, that is characteristic of the nickel aluminoid intermetallic exothermic reaction.

That is ascertained by having analyzed the material subsequently to ascertain if the aluminum content was within the range of the intermetallic material and x-ray defraction patterns which identified these unmistakably and showed the nickel aluminoid intermetallic lines.

The identification was made. And this was indeed the nickel aluminoid intermetallic reaction.

It comes from this material. And one can easily interpret that when one reaches the melting temperature of the aluminum, the aluminum begins to melt and begins to absorb the nickel which surrounds it and protects it from the atmosphere.

This is a relatively slow reaction because the heat factor is relatively small.

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And that then represents the reaction -- of course, having reached a peak which is the most rapid reaction when it first occurs because it involved the largest amount of surface, the reaction however continues because there is a continuing solution of the nickel into the aluminum, and that is why the peak remains high.

That is like a fingerprint of a man in the sense it characterizes the nature of that particular reaction, that is an exothermic intermetallic forming reaction.

THE COURT: Now, let me ask, while I am still warm on the subject, is there any difference between the proportions in regard to the two numbered product, that is to say, by proportions --

THE WITNESS: This one contains twenty percent aluminum.

THE COURT: Twenty percent. Which is which now?

THE WITNESS: 14B.

THE COURT: 20 percent?

THE WITNESS: 20 percent aluminum. And it is completely enclosed by nickel.

It is completely enclosed and therefore protected from the air, atmosphere.

* * *

THE WITNESS: The 450 and Eutectic 200 appear to be reasonably similar in structure. They are of the same composition, namely, 95/5.

They would both be in the same curve as is shown on PX 64.

* * *

THE COURT: Now, when we were examining pictures a little while ago, just to make sure I have these related to one another -- that's what I was getting concerned about -- here, now is that correct?

MR. CALIMAFDE: Yes, sir, 14-B and that is Metco 404 powder.

THE COURT: All right. So now -- I see.

MR. CALIMAFDE: That's correct.

THE COURT: Now, with respect to these charts, however, that's where I was getting a little mixed up I fear.

THE WITNESS: Now, Exhibit 15 goes with 404.

THE COURT: All right. I've got that.

3 Grant - direct

MR. CALIMAFDE: And that's 14-B.

THE COURT: Right. But Exhibit 64 --

THE WITNESS: Exhibit 64 goes with --

THE COURT: Eutectic's product, 14, all right.

THE WITNESS: 14.

MR. SPRUNG: And I believe the witness testified that the same chart would apply for Metco 450.

THE WITNESS: Yes, sir.

THE COURT: I see, all right. And that's aluminum on the outside?

THE WITNESS: That's aluminum on the outside in a binder.

MR. CALIMAFDE: And I might mention, to keep the record unconfused, Mr. Sprung indicated that 404 had nickel on the outside and 450 had nickel on the inside. That is half the statement. The second half is that the proportion of aluminum to nickel is completely different in the two.

In the 404 the proportion of aluminum is 20 per cent to nickel 80 per cent, whereas in the Metco 450, the proportion of aluminum is

five per cent to nickel 95 per cent.

MR. SPRUNG: That's correct, your Honor.

THE WITNESS: Anyway, I have described then Exhibit 65 as being characteristic of the intermetallic exothermic forming reaction and said that that is its trademark that is characteristic of that particular structural reaction, where the aluminum is on the inside, melts, starts to dissolve nickel, and goes about this relatively -- relatively slow rate of heat increase and then falls off from a peak at 800 degrees and then remains at a high upper level for a -- for an extended period of time.

In fact, in this chart out here to a thousand fifty degrees centigrade, it continues on out through that wide temperatum interval.

By contrast, the 95-5 alloy with the aluminum on the outside reaches a peak temperature very abruptly, very, very quickly -- within 40 degrees smack -- so that the peak is reached at 700 degrees rather than 800 degrees. The reaction decays equally rapidly by the fact that the curve is quite symetrical, and falls back to the original level of what the material

had been, namely, no sustaining reaction to maintain or generate heat after that initial impulse.

That too is characteristic of the behavior of this material and is its fingerprint.

Analysis of these powders after reacting in air, the 95-5 alloy, indicates that the oxide content of that material has increased from .3 per cent to 4 1/2 per cent, clearly indicating a tremendous amount of oxidation which has taken place during this particular test.

BY MR. CALIMAFDE:

Q This being 14 --

A This being Exhibit 64.

* * *

MR. SPRUNG: No, he said he analyzed for oxide content.

Did he analyze the 450 or the Exotec for oxide content?

M=2

THE WITNESS: Yes.

MR. SPRUNG: And do you have the results and how the tests were conducted? Do you have a report on it?

THE WITNESS: Yes.

MR. SPRUNG: Will you make that available?

MR. CALIMAFDE: Sure.

MR. SPRUNG: May we have a copy of it?

MR. CALIMAFDE: Yes, sir.

* * *

Q I think you probably have completed your answer to my question, which was to explain the test, what you were seeking to analyze and what the charts indicated.

A Now the charts, plus the nature of the structure of the powder, plus the analyses are therefore combined into a conclusion that in the case of the 404, namely the 80-20 composition in which the aluminum is the nucleus and is surrounded by nickel, represents, as the patent 515 indicates, an exothermal compound intermetallic-forming reaction; that by the same token the 95-5 alloy represents an oxidation reaction in which the heat is derived exclusively from the oxidation reaction by the nature of the very rapid short pulse which is commensurate with the heat effect, which I have observed earlier on the blackboard.

In other words, the -- the higher the heat of -- the higher the heat evolved the more rapid the reaction. And this is one of the laws of nature. And it's for this reason that we say that the heat generated in the 95-5 alloy is due to oxidation of the aluminum.

* * *

JA 193

Q Dr. Grant, I will hand you three sets of photographs which have been marked for identification as Plaintiff's Exhibits 63, 64A and 63B and ask whether you can identify them?

A Yes. These were scanning electron microscope views taken in my laboratory under my supervision. They represent cross-sectional views of the 95-5 alloy.

THE COURT: Now, when you say 95-5, Doctor, which photograph would that be according to the identification number?

THE WITNESS: This would be the 29 --

THE COURT: No, I mean 63, 63A or 63B.

THE WITNESS: Oh, they are all -- all separate views of the same --

THE COURT: I see.

THE WITNESS: -- of different particles of exactly the same material, from the same package.

These views were taken in an effort to get a high-magnification view with some precision

of the distribution of the aluminum particles with respect to the nickel nucleus, and what they show is an agglomerate of loosely dispersed, randomly dispersed aluminum particles around the nickel nucleus in such a way that it's clear that the aluminum particles are not in contact with the nickel nucleus, are held in the binder, well separated in most instances and often clustered out of contact with the nickel nucleus.

Q I think, Dr. Grant, it would be helpful to the Court if you could explain, for example, 63A, which in the photograph marked 1,000-X, was the cluster of what looked like miniature lights representing --

MR. SPRUNG: May I interrupt?

I don't think we have established in the record whether these -- you said this is of the 95-5 material.

THE WITNESS: Yes, sir.

MR. SPRUNG: Is this the Metco material or the Eutectic material?

THE WITNESS: This is the Eutectic material.

MR. SPRUNG: What?

THE WITNESS: This is the Eutectic material.

MR. SPRUNG: You're sure of that?

Q Is this the Metco 450 or is it the Xotec?

A This is the Exotec 29904. And we did view the others. They are, as was noted in yesterday's views, identical. That is there is no way in mixture of these pictures there would be absolutely no way of differentiating Metco or the Exotec material.

MR. SPRUNG: Well, I am just questioning this because when the exhibits were presented to us it was represented that these were the Metco material.

MR. CALIMAFDE: Well, I said that and apparently I was in error. I thought those pictures were of the Metco 450.

MR. SPRUNG: Can you identify the lot of material in the can which these were taken from?

THE WITNESS: Yes, I can. I don't have it right here, but it's in the record, yes, sir. There will be no problem about doing that.

Q Yes, now I believe there is an open question, Dr. Grant. Would you explain to the Court what appears to be clusters of miniature lights represent?

A The heavy dark mass at the center is the nickel

nucleus. That's the dull grav nickel particle. That is the neucleus.

THE COURT: Are you speaking now of this?

THE WITNESS: Yes, sir. Now the -- the view shows the aluminum particles, but very poorly, around -- that is in a scanning electron microscope view directly, shows the aluminum particles but doesn't really identify them with extreme accuracy.

What we do, however, in this technique, is to bombard this structure at this thousand magnification view with electrons so that there is an instrument pick-up of the flouresence which occurs when the aluminum is activated by the -- by the by the electron bombardment. And what that does then, is to give you these clusters that you see as white clouds in the vicinity of the nucleus but separated from it.

THE COURT: That's on this other photograph?

THE WITNESS: Yes, sir. So these clouds you see are the aluminum-rich areas and show the aluminum distribution around the particles, indicating that the -- that the aluminum is not --

does not cover the nickel particle completely, that there are large gaps where there is no aluminum at all and many, many other areas where the aluminum is heavily clustered and separated from the nickel nucleus.

Q Is it apparent from those photographs, Dr. Grant, that the aluminum is spaced from the nickel nucleus?

A Yes, sir.

Q What's the significance of the aluminum being on the outside of the nickel nucleus?

A By being on the outside on exposure to the hot flame of a flame spraying operation it means that the aluminum will reach temperature sooner, obviously, than the nickel nucleus, and since the aluminum has a low melting point of 660 degrees centigrade it means that the aluminum will begin to melt when it reaches 660 degrees, and in melting will begin burning in the oxidizing atmosphere, because that's the only thing it can do; and in burning will, of course, generate an exothermal oxidation reaction.

MR. CALIMAFDE: Would you mark this Plaintiff's Exhibit 15, please?

THE CLERK: One booklet marked for identification as Plaintiff's Exhibit 15.

(So marked.)

Q I will show you, Dr. Grant, Plaintiff's Exhibit 15 marked for identification, photographs, two photographs, which appear in the appendix 1 which is part of the report, and ask you whether you can identify the photographs?

A Yes, these are normal metal graphically prepared samples showing the cross-section of the nickel nucleus and the distribution of the fine aluminum particles so that these are in fact almost duplicates of exhibit 63, 63A and B, but made by the more conventional technique of grinding, polishing the specimens again to look for the nature of the distribution of the fine aluminum particles relative to the nickel nucleus. And the conformation in these metal graphically prepared samples with ordinary light microscopy corroborates complete the picture, presented by Exhibits 63, 63A and 63B. It shows that -- in a series of pictures that, again, the aluminum is an agglomeration -- is agglomerated around the nickel nucleus in a random fashion with only a very, very rare nickel particle which -- I'm sorry, a very, very rare aluminum particle which appears to be perhaps in contact with the nickel nucleus, and therefore essentially all of the -- virtually all of the aluminum particles are separated physically from the nickel nucleus, and in many instances, clustered in

agglomerates away from the nickel nucleus, but in all cases separated largely from each other and largely -- and almost exclusively from the nickel nucleus.

Q May I ask you, Dr. Grant, to show the Court again at least those two figures to which you were referring, pointing out the nickel portion and the aluminum portion, and the separation?

A Again, the large gray mass is the nickel nucleus. The lighter-appearing material is the fine dispersion of aluminum particles, andas one looks, one sees that all of the aluminum particles are separated physically from the nucleus and separated fom each other, being held in the binder phase.

There are large regions where there is no aluminum whatsoever in -- anywhere near the nickel nucleus. So there is physical separation, random distribution and no intimate contact.

THE COURT: Now, these follow page --

MR. CALIMAFDE: That's in the appendix 1 to Exhibit 15, your Honor.

THE COURT: Oh, it's appendix 1 following page 2. Okay.

BY MR. CALIMAFDE:

Q Is the form of the accused powder a composite?

A No, sir, I don't view it as a composite in the light of the definition that this must be an inseparable agglomeration of the nickel and the aluminum particles.

Q Would you describe the accused powder as one in which the nickel is coated or clad with the aluminum?

A No, the -- the definitions of coating and cladding to me have always implied something of a continuous nature. I see in the accused material instead, an agglomerate with randomly dispersed fine aluminum particles which are in no way bonded directly to the nickel nucleus, and therefore in no way coat or clad the material.

Q Will you now refer to example 31 in the patent in suit, number 515. In column 13, Dr. Grant --

A Yes, sir.

Q -- Column 13 of the 515 patent.

A Yes, sir.

Q And if you will pause for just a moment, yes, example 31 is at the bottom of the column 13. Do you see it?

A Yes, sir.

Q Now, will you compare the form and proportion of the powder described in example 31 with the form and proportion of the accused patent.

A The -- in example 31 the form is such that the description stated that "All of the nickel-core particles

were clad with a gray film which consisted of aluminum particles bonded to each other and to the core material by the phenolic binder."

Our photograph s submitted here as these exhibits do not indicate that the aluminum particles are bonded to each other or that they are bonded to the nickel, and instead they are dispersed in a random fashion out of contact with each other, and out of contact with the nickel nucleus.

Furthermore, the accused powder is a 95 nickel, five aluminum composition. Example 31 calls for a powder which is 15% aluminum and 85% nickel, which in terms of the phasing diagram would take it out of the solid solution area of the 95-5 and place it into the very middle of the intermetallic phase at the 8515 level.

Q Dr. Grant, would you now tie up for us as best you can, a comparison of the patent powder of the composite type with the -- and compare that with the accused powder, both in form, proportion and the nature of the heat-generating mechanism?

MR. CALIMAFDE: Do you have a --

THE COURT: Do you want one with a wider brush to it for thatpurpose?

THE WITNESS: I think it would help.

THE COURT: Why not try this and see if it

words.

THE WITNESS: Thank you.

If we consider the 404 versus the 29904 --

Q Now, that's a new number.

MR. CALIMAFDE: The 29904 is the accused powder, your Honor. That's the Exotec.

THE WITNESS: Ni 95-5 aluminum. And the 404 is 80 nickel, 20 aluminum.

Now the exhibits indicate that the 404 is composed of an aluminum matrix with a clad coating of nickel which is rather perfectly continuous and fully matches the description of a coating or a cladding.

The accused material is a similar sized particle approximately the nickel nucleus with random distribution of fine aluminum particles held in a binder, not in contact -- the aluminum particles are not in contact with each other, they are not in contact with the nickel, so in effect --

THE COURT: May I interrupt you just a moment, because I do have a misunderstanding here.

I thought you referred to the 404 as the

accused Exotec.

MR. CALIMAFDE: I'm sorry, no, the 29904 is the accused Exotec.

THE WITNESS: You're calling it the patented powder.

Q And to be consistent I think you should show which is the aluminum?

A Yes. Those are the aluminum particles.

Now, we have also shown that when you heat the 404 type of material it generates its own classic signature, in the sense that the maximum occurs at a temperature of about 800 degrees centrigade and that there is an after-effect, a heating aftereffect due to the continuing reaction between the aluminum and the nickel after the aluminum has melted inside of this nickel core, of the order of perhaps 12 - 15, although that number is not precise, but there is this aftereffect..

And the rate at which the peak is reached is rather slowly.

By comparison the accused material reaches its peak at 700 degrees and falls back to a value of nil for the aftereffect. So that these two represent two totally different thermal excursions during the heating operation. And the patented material, the 80 nickel, 20 aluminum

represents the formation as described in the patent, and exothermal compound, intermetallic compound-forming reaction. And it is our contention that the 95-5 represents a much more violent exothermic reaction, also exothermic but clearly an oxidation-type reaction.

* * *

THE COURT: Yes. May I ask of Dr. Grant, when we mentioned -- when you mentioned the other being exothermal but oxidation, is that -- are you saying -- I see you have jotted down --

THE WITNESS: It's the reaction between aluminum and oxygen to form aluminum oxide, which is the large heat evolution reaction which I showed yesterday on the blackboard.

Q I think for my benefit, and perhaps the Court's, Doctor, you should compare as best you can in language I understand, the similarities and/or differences

between the exothermal reaction which occurs in the 80-20 powder with the exothermal reaction that occurred in the accused powder?

A Well, a powder of this sort, the 80 nickel, 20 aluminum patented powder in the flame will reach a temperature such that the aluminum will become molten while the nickel is at the same temperature.

For example, it would become molten at 660 degrees centigrade. At that point the reaction begins across this interface between the nickel and the aluminum. Because of the magnitude of this exothermal reaction, the process is very slow, but it is contained and the particle is elevated above and beyond what the temperature from the flame would be, so that there is an exothermal reaction additionally added to the flame temperature as a result of the formation of the intermetallic compound, which forms the Ni Al or Ni Al intermetallic compound.

THE COURT: If I may try to state it in layman's terms, are you saying that the nickel in a sense forms a barrier which --

THE WITNESS: Which contains and protects the nickel against -- I mean the aluminum oxidation.

THE COURT: The aluminum against oxidation?

THE WITNESS: Yes, sir. This is specifically called for as a matter of fact, in some of

the examples.

Q Would this form of exothermy occur in the absence of oxygen?

A Oh, yes, sir. This is -- this is completely independent of any requirement for oxygen since the heat that is generated is that of the well known exothermic intermetallic-forming reaction.

Q So that strictly the heat generated by these two metals reacting with each other, is that correct?

A Yes, sir, strictly acting with each other. No need for any oxidation for contribution.

By contrast this accused powder 95-5 when it sees the flame termperature, when 660 degrees flame temperature is reached at that stage of the game, the binder will have burned off, since the binder begins to burn off at a temperature as low as 250 degrees, and that exposes the aluminum particles to a strong, hot oxidizing flame.

At that stage, the aluminum particles will -- will and can separate from the -- from the nucleus and begin burning to give this rapid temperature pulse which occurs very shortly after the melting has occurred, with a peak at 700 degrees centrigrade, and that is gone very quickly. It is a flash because it's a high heat evolution. The process takes place very quickly, and once the aluminum

is burned there is nothing there to sustain any reaction, and that is why the temperature pulse that we see here falls back to the original level.

And there is therefore physical separate of the aluminum from the particle as the binder is burned away, permitting the aluminum to become oxidized in the oxidizing atmosphere of the flame.

Q Dr. Grant, if the binder is burnt off at 250 degrees --

A Starting at 250 degrees. It continuously then burns off over -- over several hundred degrees.

Q Do I understand your testimony correctly that after the binder has burnt off the aluminum particles are now just freely floating in the surface about --

A Some -- some of them are, depending on -- depending on the convection currents and such. Many of the aluminum particles will be released from the binder and will burn.

Q And now when the molten temperature of the aluminum is reached is the heat generated as a result of the reaction between the nickel and the aluminum?

A No, sir, no, sir, because, as a matter of fact, they are physically separated there is no opportunity even if the composition ~~are~~ WERE right. Instead we get aluminum reacting with oxygen to give an aluminum oxide and there

is a large exothermic contribution from that oxidation reaction which is measured by this characteristic signature of a temperature pulse.

Q So at this heat in the accused ~~pattern~~ powder is a direct result of a reaction between the oxygen and the aluminum?

A Yes, sir, exclusively.

Q Now, if you didn't have oxygen in the atmosphere where you were attempting to heat the accused powder, what would happen, what type of reaction would occur?

A Well, there is always a little bit of oxygen present in any circumstance, and there might be a very tiny contribution. But assuming a very clean atmosphere there would be no contribution, for the simple reason that the aluminum would simply melt and not being in contact with the nickel would not generate any heat of -- of any measurable significance.

Q Now, in this type of exothermic reaction, the so-called oxidation reaction, was that a known heat generating mechanism prior to 1960?

A Yes, sir, it was well known and described in prior patent ~~litigation~~ literature.

Q Now, does it make any difference whether the aluminum is attached to a nickel nucleus or attached to, let

us say, an oxidized nucleus in terms of what the heat generating mechanism performs?

A No, sir, if the aluminum is on the outside and bonded, for example, with a binder, then the aluminum will behave in the same way whether it is randomly agglomerated around an oxide particle or any metallic particle.

* * *

Q Now, Dr. Grant, I would like you to compare the structure, function and result of the patented powder with the accused powder in terms of the nature of the material or the form of the material, whether it be composite or whether it be individually clad particles consiting of the nucleus of nickel with a coating of aluminum; and I would also like you to compare again the structure, function and result of the patented powder which has its characterized clause, "Characterized by the ability of generating heat" and so forth, with the accused powder.

THE COURT: Do you understand the question?

MR. CALIMAFDE: You don't, sir?

THE COURT: I am having a little difficulty.

Q I would like you to compare the structure as the structure is defined in claims 4 and 14 with the structure of the powder -- of the accused powder.

A All right, 4 calls for a composite, metal spraying --

flame spraying composite formed of aluminum and nickel, characterized by the ability to generate heat during flame spraying which aids in bonding to the surface being sprayed.

The accused material is not a composite in the sense defined by the patent. The ability of generating heat as defined by the patent is that of an exothermic intermetallic-forming reaction. The accused material does not form an intermetallic and therefore does not generate heat from any intermetallic-forming reaction.

In terms of 14, the accused material does not have a coating of finely divided aluminum bound to the nucleus; instead what I see in the accused material is an agglomerate of randomly dispersed aluminum particles which are not in contact with each other, and not in contact with the nickel nucleus as a coating.

* * *

Q Is there a difference in the end product one would attain as a result of heating the powder in an oven to the temperature at which the exothermalicity occurs, as compared to flame spraying the powder?

A Small differences, yes.

Q And will you explain those differences to the Court, please?

A The process in heating an over would obviously be somewhat slower, the actions, particularly the -- the exothermal intermetallic forming reaction would probably proceed somewhat more thoroughly, somewhat more perfectly in the oven because more time is allowed.

But on the other hand, as far as the 95-5 accused

powder is concerned, because the reaction is an extremely rapid one, the oxidation of the aluminum from the atmosphere, that is an extremely rapid reaction and whether you heat it in an oven with an oxygen atmosphere or whether you put it in a flame spray operation, that heat effect would remain roughly the same because it is a very sharp pulse which takes place very quickly.

Q Yes. Can you compare for us based on your experience with these two powders at the laboratory at MIT, can you compare the end result of the 80-20 powder after it had been reacted with the end result of the 95-5 powder?

A The 80-20 affect reacted in the oven does what the patent says, it shows an identification of the intermetallic nickel aluminide product.

After reaction of the accused 95-5 material, you do not find any of the intermetallic lines, and instead, you find that the aluminum has been largely burnt up.

So that one ends up as -- that is the 80-20 ends up as an intermetallic material, the 95-5 certainly does not end up as an intermetallic material.

Q Now, earlier in your testimony, you indicated that you had read the 515 patent. In reading that patent, Dr. Grant, you understand that the disclosure is directed

to the making of a coating of any particular composition or compound?

A Excuse me, again, please?

Q In reading the patent in suit --

A Yes.

Q (Continuing) -- do you understand from reading it, that the end product desired, the coatings desired have a particular composition?

A Yes, sir.

Q What is that?

A That composition has to be within the intermetallic range, meaning that the composition of the aluminum in that coating would have to be significantly above five per cent aluminum.

* * *

Q Now, you have been commenting on the patent in suit, the 515 patent; is that correct?

A Yes, sir, right.

Q And in reading this patent, you understand the patent to mean that it is producing a coating which has the nickel aluminide?

A Yes, sir.

Q Now, I think you have answered it a dozen times and just to be sure the record is straight, do you get a nickel aluminide in your reaction of the 95-5 powder?

A No, sir.

Q Now, have you read and do you understand the second patent in suit bearing the last three numbers 248?

A Yes, sir.

Q Will you please briefly describe the differences, if any, between the two patents 248 and the 515?

A 248 differs in that it addresses itself to the flame spray process, and its claims so read, in which by the flame spray process of 248, one utilizes the materials which are described in 515.

Q So that for brevity, the 248 claims the process of spraying the powder which is claimed in 515?

A 515, yes, sir.

Q Now, in spraying the nickel aluminum powder having the proportions specified in the patent, is the composition of the sprayed coating predictable in light of the prior art?

A Yes, sir.

Q Is the nature of the reaction predictable in light of the prior art?

A Yes, sir.

Q And is the ~~boding~~ bonding predictable in light of the prior art?

A Yes, sir.

MR. CALIMAFDE: Your Honor, I direct the

Court's attention to the patent 248, column 6, beginning at line 25. I shall just read that one sentence, and I quote:

"The spraying in all other respects is effected in the conventional well known manner using conventional flame spraying equipment and the conventional surface preparation may be utilized if desired."

I read that to the Court in the context of the claims in this patent being directed to the process for spraying the powder.

* * *

CROSS-EXAMINATION

BY MR. SPRUNG:

cxxx Q Dr. Grant, did you ever flame spray either of these materials?

A No, sir.

Q You didn't?

A No, sir.

Q Did you ever flame spray any materials?

A No, sir.

* * *

Q Now, Dr. Grant, you have a very impressive list of publications, and I checked them back to 1950. I read them and I think we gave you your attorney's copies of these publications that we were able to uncover, and I saw you looking through.

Would you point out which ones of them relate to flame spraying?

A As I remember, there are over many, many years, many, many of them, and I don't know if this is a very desirable exercise.

There are many articles having to do with powder metallurgy --

Q I'm talking about flame spraying.

A None of them have anything to do --

* * *

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Q Now, I say again, are any of your articles directed to flame spraying?

A No, sir.

* * *

MR. SPRUNG: And I just wanted to establish that this witness -- and I recognize that he is one of the eminent experts in the field of metallurgy, and maybe powder m allurgy, but I want to establish he has no real knowledge as a skilled artisan in the flame spray field.

THE WITNESS: I admitted that.

* * *

Q Twenty years. Let's go back twenty years ago. Do you have any knowledge of how twenty years ago a bonding of the flame-sprayed material through a metal substrate was effected?

A Bonding of which flame spray --

Q Any flame-sprayed material to a metal substrate?

A How it was accomplished?

Q Yes.

(Continued on next page.)

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A Are you looking for a specific kind of bonding, or --

Q Bonding. I want a flame spray -- We'll go back 20 years. I want a flame spray, say a steel coating, or any other material which was known to be available at that time, onto a steel plate. How would the bonding be effected?

A Are you asking how you accomplish a bond?

Q How they did 20 years ago.

A Well --

THE COURT: He's asking --

A (continuing) -- Are you asking for a procedure or are you asking how they accomplished the bond?

Q The procedure by which they accomplished the bond.

A One said either a wire through a wire gun or a powder through a powder gun, and attempted to spray this onto the surface which had been cleaned, perhaps roughened, in order to try to accomplish a bond.

Q I see. And according to your understanding of flame spraying, if you just sprayed this material on, it would bond and form an adherent coat?

A I didn't say that.

Q Well, that's what I'm asking you: how did they

make it stick 20 years ago?

A Well, they didn't always make it stick.

Q Well, they had problems making it stick?

A Oh, yes, sir.

Q And what were the known ways that they could solve those problems 20 years ago and make it stick?

A One way was to subsequently torch it --

Q Let's -- if I may interrupt, in my examination, when I speak of flame spraying, I'm speaking now, so that we understand each other, of spraying on a relatively cool substrate, and do not include spray-welding or -fusing; do you understand that?

A Yes, sir.

Q So how would they make the spray material stick?

A If you wanted to be sure that you had a good opportunity to obtain a good weld, you'd probably use a molybdenum wire and spray this to form a substrate, prior to trying to spray the coating on top of it.

Q I see. And molybdenum was available 20 years ago?

A Yes, sir.

Q What?

A Molybdenum, yes, sir.

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Grant - cross

Q For flame spraying?

A I don't know if it was available -- 20 years ago would be '53.

Q '53.

A Yes, I think so. About --

Q And that was your first experience, in around the 50's?

A Not my experience, my knowledge.

Q Your first knowledge?

A Yes.

Q So molybdenum could be used as a self-bonding material?

A Yes, sir.

Q Do you know anything else that could be used as a self-bonding material?

A Not particularly successfully, no.

Q Is it fair to say that in the flame-spray art, 20 years ago, the only practical self-bonding material was molybdenum?

A Probably.

Q You have no disagreement with that statement?

A No basic disagreement, no.

Q Do you know if there were any problems with molybdenum as a bond coat at that time?

Grant - cross

A Oh, surely, lots of them.

Q Would you tell the Court a few of them?

A The quality of the wire wasn't the greatest in the world. It was expensive. It was stiff. It was relatively difficult to feed through a gun. Molybdenum has an extremely high melting point, and therefore the problem of getting a proper temperature in order to accomplish the melting of the wire and its transfer would all have presented significant problems.

Q How about the temperature resistance characteristics of the molybdenum coating? That should be well within your field?

A Well, depending on what you wanted to use it for. If you were -- if you were going to use this for low temperature corrosion-resistance purposes, the molybdenum could be perfect as a substrate.

If you were looking for high temperature exposure, the molybdenum was well known to oxidize very rapidly at temperatures above 600 degrees, centigrade.

Q So is it fair to say that generally, molybdenum would not be as satisfactory material if the ends would be subjected to temperatures above 600 degrees Fahrenheit?

A Centigrade.

Grant - cross

Q Centigrade?

A Yes, sir.

Q And what bonding material was available, self-bonding material which you could use as a bond coat if you wanted to subject the flame spray coating to these higher temperatures?

A 20 -- you are still talking about 20 years ago?

Q Yes.

A None that I know of that would be particularly successful.

Q Now, you are familiar that 20 years ago they sprayed wire on powder, flame sprayed --

A Of what?

Q Just in general. I'm just talking in general flame spraying, they had a wire process. You spoke of spraying molybdenum wire?

A Yes.

Q And they also sprayed powder?

A Molybdenum powder.

Q No, I'm not talking about molybdenum.

A Powders generally, yes.

Q Did they have any known satisfactory self-bonding flame spray out?

A 20 years ago? No, sir.

* * *

Q Let's start with a commercially available, a material that was used practically in the flame spray field, to your knowledge. Let's start through the years.

A Well, Montgomery describes, in 1956, a Cermet material which I know was used. How extensively it was used, what success it had, I don't know. It was relatively small, but it was used.

Q As a self-bonding material?

A Yes, sir.

Q Where do you have knowledge of such use of -- Let me ask you: Have you ever tried spraying the Montgomery material?

A We just went through this. I did not and have not sprayed any material.

Q All right, do you have any knowledge of any one who sprayed the Montgomery material and had it

self-bond?

A Yes, sir, but not commercially.

Q Who?

A In our own laboratories at MIT.

* * *

Q Yes. Do you know any other materials that are available?

A Yes, the -- the Gutzite material has been used.

Q As a self-bonding material?

A Yes sir. And he so reports extensively in his own patent and the literature subsequently. And it has been used

Q Would you define those patents and literature where they define the Gutzite material as a self-bonding material?

A Well, it's -- Gutzite --

Q Are you talking about the patent?

A Yes sir, yes.

Q Any other material besides that patent?

A No.

Q Would you show me where that patent reports it as being a self-bonding material; indicate the page and line

where self-bonding is indicated?

A All right, let's look at column --

Q Wait until I get mine.

A Column 7 line 16: "The nickel-phosphorous alloy of the coating is very advantageous in that it has a relatively low melting point, normally around 880 degrees C. 2950 degrees C., and the phosphorous content thereof acts as a deoxidizing agent, resulting in the capability of the molten droplets or globules to wet most metals even though they are coated with thin, unwettable oxide films."

That to me is self-bonding.

Then again line --

Q May we go into --

A No, no, I'm sorry, you asked -- Let me finish. Line 23: "For example base metals containing substantially chromium, the usual stainless steels, are readily wetted by this alloy for this reason, whereby a coherent coating of the character described may be readily flame sprayed upon a base material containing substantial chromium, which coating is characterized by good adhesion notwithstanding the usual unwettable oxide films carried by such stainless steels."

And then again line 56: "This composite coating offered very remarkable resistance to corrosion in a salt spray test, indicating a life of about 300 hours."

And that could not be accomplished without it having been bonded. And since the flame spray operation bonded it, it was a self-bonding operation.

* * *

Q Now, is it true that the self-fluxing spray-weld alloys, these types of alloys have been available for more than 20 years, and have been used in other places for the spray-weld process?

A Yes.

Q And have these materials been used as self-bonding materials?

A Yes, they have been put on as self-bonding materials.

Q Without a fusing operation?

A Yes sir.

Q Can you cite any --

A There are fluxing operations of this sort which that element, the reactive element, does do.

Q In other words, then, you want to change your testimony that molybdenum was the only self-bonding material known? It is your position that the standard spray-weld alloys were also self-bonding?

A No, you wouldn't use these as an undercoat.

Q I see. Isn't phosphorous in the same class as boron as a fluxing element?

A It's in the same class with aluminum as being a fluxing element.

Q And according to your understanding this material has been commercially available as a flame spray material for --

A Which material?

Q The Gutzite material?

A Yes sir, it has been used -- it has been used commercially. Yes sir.

Q Can you give us an instance where it has been used?

A No I can't, but it has been used --

Q Well, what do you base your testimony on that it has been used commercially?

A Literature.

* * *

THE COURT: Which of the four is understood to be virtually identical with one of the Exotec?

MR. CALIMAFDE: The Exotec, your Honor.

THE COURT: Is that -- that's Exotec?

MR. CALIMAFDE: Yes, sir.

THE COURT: So that's -- no, wait a moment, Exotec, oh, that's 29904? I put the number down.

MR. SPRUNG: Can we for the --

MR. CALIMAFDE: Let me --

MR. SPRUNG: -- uniform terminology refer to that as Exotec rather than as 29904?

MR. CALIMAFDE: Yes, because I think the number is confusing.

MR. SPRUNG: Shall we call that Exotec?

THE COURT: All right, standardize our terminology.

MR. SPRUNG: All right, now will you stipulate as you have answered interrogatories that Exotec and Moguloy M55 are identical?

MR. CALIMAFDE: Yes.

MR. SPRUNG: All right, so we're out two.

THE COURT: Exotec and Moguloy M55 are

identical.

MR. SPRUNG: Now, will you stipulate that the Durotec is merely the Exotec admixed with a further material?

MR. CALIMAFDE: Well, I think we ought to identify what this further spray flame material is.

The first part of your statement is correct, that the Durotec consists of 10% of Exotec -- and what's the remaining 90%?

MR. SPRUNG: 90% of a nickel base self-fluxing alloy, is that correct?

MR. CALIMAFDE: That is correct.

All right, but in any event, that contains 10% of the Exotec. That in particular.

MR. SPRUNG: Correct. And Xuperbond is identical in structure and composition to Exotec except it contains an additional coloring material.

MR. CALIMAFDE: No. No. Xuperbond I understand became about 95%, something less than 5% aluminum and a small percentage, like 1 and a half percent of a material, an additive material.

MR. SPRUNG: A coloring material.

THE COURT: Well, can't we agree on that for the present purposes, that Xuperbond.

MR. CALIMAFDE: Xuperbond.

MR. SPRUNG: Has the same physical structure.

MR. CALIMAFDE: Has the same form, with the nickel nucleus.

THE COURT: Same form as Exotec, is that correct?

MR. CALIMAFDE: Yes, sir.

THE COURT: And the differences are --

MR. CALIMAFDE: It contains --

THE COURT: 95 nickel.

MR. CALIMAFDE: Right.

THE COURT: Aluminum what?

MR. CALIMAFDE: And less aluminum, something like 3 plus.

THE COURT: Roughly? All right.

MR. CALIMAFDE: Yes, sir.

Roughly 3 plus.

THE COURT: All right, three plus. And the other --

MR. SPRUNG: We'll establish --

THE COURT: Answer the other secret.

MR. CALIMAFDE: The other is one plus of an additive.

THE COURT: Additive 1 plus.

MR. SPRUNG: I won't stipulate to that amount of aluminum. I think our analysis shows --

THE COURT: Well, I wasn't even thinking of it so much in terms of the stipulation as an answer.

MR. SPRUNG: I have an answer to interrogatory number 85, your Honor.

Xuperbond is 5% aluminum powder of 325 ~~measure~~ MESH, 1% of this other ingredient, 1.5% of the other ingredient --

THE COURT: 325 aluminum powder.

MR. SPRUNG: 5%. So it has the same content of aluminum as Exotec.

THE COURT: Did you say 1%?

MR. SPRUNG: 1.5%.

THE COURT: 1.5%.

MR. SPRUNG: Of the additive.

MR. CALIMAFDE: May I state for the record that that's the answer you got in the interrogatories. That's correct.

THE COURT: Did you say 3% or 5%?

MR. CALIMAFDE: I said 3% and it was wrong, your Honor. 5% aluminum.

MR. SPRUNG: Then I am correct, that is identical to Exotec except that it contains about 1 and 1 1/2% additive, is that correct?

MR. CALIMAFDE: Well, 5% aluminum, 1 plus of the additive, so necessarily it has something less than 95 nickel.

MR. SPRUNG: You're right.

THE COURT: Well, it adds up to a hundred somehow, doesn't it?

MR. SPRUNG: Balance, balance.

THE WITNESS: Yes, sir, ultimately.

THE COURT: Now, let's see, what's the other one, Durotec? Is there any need to establish what we're talking about?

MR. SPRUNG: Durotec is merely 10% of Exotec, and admixture with another spray flame material.

THE COURT: Let me hear that again, 10% --

MR. SPRUNG: It's a mixture of powders. It's ten percent of the Exotec material and 90% of another spray flame material.

THE COURT: 90% of another.

Excuse me, just a moment.

Go ahead, Mr. Sprung, I'm sorry.

BY MR. SPRUNG:

Q Dr. Grant, you were testifying about the familiarity with the Exotec material. Do you have any familiarity with any of the other materials which we discussed?

A No, sir, I have no -- I have only made my tests with the Exotec.

Q And you're only familiar -- you are -- your testimony then only relates to the Exotec?

A Yes.

Q Then we'll have to just limit this to Exotec, and when I speak of the Eutectic material you will understand I am talking about the Exotec.

A Yes.

Q Now, do you have any understanding as to how the Exotec material is manufactured?

A Yes, sir.

Q How is it manufactured? Will you describe for the Court?

A Nickel nodules --

Q What size?

A 70 microns, 60 - 70 microns in diameter.

Q Minus 325 mesh?

A No, coarser than that. Minus 325 mesh is 44 microns, so this would be perhaps -- this would be perhaps more like --

Q May I interrupt you for a second?

THE COURT: Did I understand you to say nodules or modules?

THE WITNESS: Nodules. It would be about minus 250 mesh I would think.

Q No, it was my understanding from our discovery that the aluminum powder was minus --

A I'm sorry, I thought you said nickel.

Q I'm sorry.

THE COURT: He said nickel.

Q Then we're at cross purposes. I'm sorry, that was my error and will you accept my apology.

The nickel powder is --

A About 60 - 70 microns in diameter. Nickel powder.

Q Okay, so let's start, we have nickel powder 60 - 70 microns in diameter.

A Yes. Aluminum powder generally of minus 235 mesh, which is minus 44 microns, but from what we have seen considerably smaller than that, more nearly like minus 10 microns and finer. And when I say minus 10 I mean 10 would perhaps be the largest and then go on down to 1 or 2

microns.

Q . Very fine.

A Yes. Blended in some sort of a --

Q May I interrupt?

MR. SPRUNG: Is your Honor familiar with screen sizes or screening? Would you like --

THE COURT: I am and I will iterate pretty much in that in the sense --

Q Would you explain just --

THE COURT: I understand the idea of decreasing mesh, if that's what you mean, and guaging the sizes of things by the mesh they pass through.

THE WITNESS: Yes. Well what I think Mr. Sprung is aluding to is we tend -- and the literature is full of it -- we tend to use both the metric system, which talks about micron sizes, which are absolute numbers, and we also talk about mesh sizes, which has to do with the number of openings in a screen, and that's an inverse number, the number gets larger.

If we talk about minus 325 mesh it means that you have that many wires in an inch of distance and it's the particle that falls through

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these wires so the pa[illegible]e gets smaller.

THE COURT: Right.

THE WITNESS: Now, there are tables that interchan[illegible] these rather well. For example, 325 mesh equals 44 micron[illegible] 100 mesh equals 150 mi[illegible]. This is -- you know, there are reference charts of th[illegible]ort.

Q I hand you a screen-size scale. Does that accurately relate screen size to mesh?

A Yes, this is --

MR. SPRUNG: Let's mark this as an exhibit.

MR. GORDON: Ir.

THE COURT: IR. Is that an agreed --

MR. SPRUNG: No, this isn't in our folder.

THE COURT: Is it IR for irregular?

MR. SPRUNG: Irregular.

THE COURT: All right, it's called a screen mesh chart, is that what you call it? What's it called? DX something anyway.

THE WITNESS: Screen analysis I suppose.

THE COURT: DXA or what's the number?

MR. SPRUNG: It's a screen scale as they call it.

THE COURT: DX --

MR. ~~GORDON~~: IR.

THE COURT: Just IR.

MR. SPRUNG: Like Internal Revenue.

THE COURT: Yes, I get it. And what's the designation?

MR. SPRUNG: It's a screen -- known as a screen scale.

THE COURT: Is that acceptable?

THE WITNESS: Yes, it converts screen analysis into the metric system, which is an absolute number.

MR. SPRUNG: May I had this to your Honor?

THE COURT: Surely.

MR. SPRUNG: If you would look in the center of the chart it gives the microns size, and to the right, which we're interested here, it gives the U.S. Standard screen size that corresponds. So from that if we speak about microns we can look at screen size. But we must remember that if something has a certain micron size, it probably will be retained on a screen that size. If we say minus 325 mesh it means all the particular pass through this finest screen.

THE COURT: I will put an upper and lower on the I because we'll be calling it 1R.

MR. SPRUNG: Your Honor, when you use the word minus it means it passes through the screen of that size.

Q Is that correct?

A Yes, sir.

Q All right, so we're starting off with --

A We have subject -- well, one to ten micron aluminum particles, which are then mixed in a paste of a variety of different materials which could be used. They are binders in one sense or another, glues, varnishes, however you want to define them.

Q Do you know the material that Eutectic uses to make Exotec, do you know if it's phenolic varnish?

A I have seen it in the patent literature. I don't know --

Q Now, I am talking about the Exotec, the actual material.

A Yes, I have seen it. I don't recall precisely the material but I have seen it.

Q It's a phenolic varnish. So would you proceed --

THE COURT: Well, let me: You mean Exotec is also a phenolic?

MR. SPRUNG: No, that's what we're talking about, the process. I believe from our -- is that correct -- from our interrogatory answers the binder was identified as a phenolic varnish or phenolic binder.

THE WITNESS: Yes, there is nothing particular about which one is used. It's a matter of cost and viscosity or thickness to be able to maintain or float the aluminum particles in the varnish.

BY MR. SPRUNG:

Q You mix the aluminum particles in?

A To produce more or less of a paste.

Q Is it like an aluminum paint?

A Yes, I think that's a fair description except aluminum paint we normally think of as being flake material instead of granular but apart from that, quite similar.

Q Then what do we do?

A This then is used to coat onto the -- to the varnish itself, and in being coated onto the nickel nucleus carries with it particles suspended in the varnish.

Q How do they do it, they just mix the aluminum paint so to speak with the aluminum particles, mix them up together?

A That I don't know.

Q What would you assume?

A I would rather not assume since I don't know frankly what the precise step is for -- for the coating of the varnish onto the metalic particle.

Q Well, we have -- we'll establish that, but it is some way mixed up so that the aluminum paint coats on the nickel particles?

A Yes.

Q And then it is dried?

A Then it is dried so that the material does become free-floating. That is the purpose here of producing this kind of a mixture of two metals in a -- with a binder is so that the material will flow freely into a -- into a flame spray gun.

Q And the amount of aluminum is about five percent by weight based on the nickel?

A Yes, by composition it is five percent.

Q And that's the manner in which the Exotec material is formed; is that correct?

A Yes, sir.

Q Have you seen commercial samples of the Exotec material?

A Yes, I have.

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Q I refer to Defendant's Exhibit K-H.

A You are making this difficult.

Q And is that the commercial Exotec that you have seen?

A Yes, sir, as far as I know. I presume that's what's in it.

Q Would you read the label for the record?

A "Exotec 29904, self reacting composite powder for bond coat, 1000 grams. Formulated for use only with the Rototec gun."

Q It's defined as a composite powder; is that correct?

A Well, that's what it says there, yes.

Q That's all I am asking, what it says on the label.

A Right.

* * *

BY MR. SPRUNG:

Q Now, Dr. Grant, would you refer to your copy of the 515 patent, which you testified to?

A Yes.

Q Now, I believe you read at the bottom of column 4 a mode for forming the clad powder; is that correct?

A Yes, sir.

Q I would ask you to turn to the next page at the top of column 5.

Does that not state a preferred and greatly simplified mode of forming the clad powders? Why don't you, since you have read the previous portion, why don't you read that into the record while you are reading it.

A Well, I am reading the first part first to refresh my memory.

"A preferred and greatly simplified mode of forming

the clad powders in accordance with the invention is the depositing of one component of a coating in the form of a paint on the other component. Thus one of the components which is to form the coating or cladding may be dispersed in finely divided form in a binder or lacquer so as in effect to form a paint in which this component corresponds to the pigment.

"The paint is then used to coat ~~four~~ THE particles of the other component and the binder or lacquer allowed to set or dry. The binder material is preferably a resin which does not depend on solvent evaporation in order to form a dried or set film, and which film decomposes or breaks down in the heat of the spraying process.

"The binder, for example, may be a phenolic varnish other than other known or conventional varnish, preferably containing a resin as the varnish solidifies. The component which is initially mixed with the binder or varnish should preferably be as finely divided as possible, as for example, minus 325 mesh" -- that's minus 44 microns.

"The other components which constitute the core should be approximately or only slightly below the particle size ultimately desired for the spray powder.

"The coating of the core component with the paint may be affected in any known or desired manner and it

is simply necessary to mix the two materials together and allow the binder to dry or set, which will result in a fairly free-flowing powder consisting of the core component coated, with a cladding or other component bound in the binder."

Q All right, now would you -- you have described the production of the accused Exotec material. Would you tell the Court any differences in the procedure of making the Exotec from that general procedure described in the 515 patent?

A I am not familiar that there is -- with the fact that there is any difference.

Q Well, according to your understanding, Exotec powder is made as described in this portion you just read --

A I think so.

* * *

Q Does this describe the procedure by which you are supposed to get a coated or clad powder?

A It describes a procedure for making a powder but it does not guarantee that you will get a coated or a clad product by my understanding of what a coated or a clad

material is, as we have --

* * *

Q Let's go a little further. Then you interpret the word coating or clad as meaning completely engulfing the nucleus, is that the distinction you are drawing?

A Yes, sir.

Q Would you show me in the patent where it says that the coating must completely engulf?

A It doesn't. I am going by the definition we discussed earlier, definitions and meanings of words and I have looked up the words coating and cladding and if I go into the metallurgical literature and I take a look at a definition of a coating or a cladding -- for example, a -- when you electroplate to produce a coat, when you talk about cladding a material by rolling or by extruding, to me the word cladding

or coating designates a continuous covering, which is what the dictionary will also tell you.

Q I see.

Now, when you mix -- when you follow this procedure as described on the top of column 5, will the nickel particles be clad with something?

A With a resin.

Q So you are coating the nickel particles?

A With a resin, yes, sir, that's the --

Q Well, with the material as described in the patent, an aluminum paint with a binder.

Now, if I take a paint and coat a wall with the paint, suppose I have very sparse pigment, am I still coating if I put the lacquer layer on?

A You are most certainly not coating it with aluminum.

Q Where does it say it has to be coated with aluminum?

A Well, all of the literature --

Q I am asking the patent, we're talking about the patent. I want you to point out where it points out in the patent that by this method you have to have a continuous coating of aluminum on the nickel?

A It says, "The coating of the core component with a paint may be effected."

Q All right, with a paint.

A Wait a while. "And it is simply necessary to mix the two materials to allow the binder to dry, the result consisting of the core component coated with a cladding of the other component, bound in the binder."

The binder -- the binder does nothing there for any other reason by this statement except to bind the particles, but the component is coated with a cladding of the other component, which to me means clad or coated with aluminum.

Q You have read the whole '95 patent; is that correct?

A Yes, sir.

Q And it is your understanding that the patent is limited to a material in which one one metal has to completely engulf the core material, is that --

A No, sir, no. I am talking about this one.

Q I am talking about the patent.

A Well, now, we have changed the subject. If we are talking about the patent we can pick other materials such as wires such as --

Q No, I am talking about powders, powders in accordance with the patent.

A As I read this, this does not describe 95-5 --

* * *

Q All right, let us look at -- What is 63B?

A 63B represents a nickel nucleus, several nickel nuclei, with aluminum, fine aluminum particles, suspended in a -- in a binder around the nickel nucleus.

Q And --

A With large -- with large gaps, very, very large gaps.

I would say here that perhaps the bonding is less than twenty percent.

Q Let us look at 15. Do we have Exhibit 15?

A That's it.

Q Let us refer to -- does this have a separate number? "Form number two" it's written, in the appendix to --

A Appendix one.

Q Yes. Now, I want to have you compare the gaps in the coating in these cross-sections, with Fig. 2.

A I don't see the slightest similarity between these two, because figure two in the 515 patent, shows intimate bonding, intimate contact of nickel with aluminum, with no varnis

interposing.

On the other hand, Exhibit 15, shows discrete aluminum particles not in contact in any way with the -- with the nickel nucleus.

Q Dr. Grant, we are not talking -- I am talking about the continguous nature of the coating, including the binder and what's in it. Does this show a more ~~contiguous~~ CONTINUOUS or less ~~contiguous~~ CONTINUOUS -- and when I refer to the microphotograph in Exhibit 15, which is dated November 5, '73, I am talking about the coating, the binder and the aluminum particles.

Is that more or less continuous than is shown --

A Very, very much less ~~contiguous~~ CONTINUOUS.

Q In other words, it is your testimony that the binders with the particles do not completely surround the particle of the nickel?

A Are we talking about the binder being ~~contiguous~~ CONTINUOUS --

Q I am talking about --

A (Continuing)--or the aluminum being contiguous?

Q I am talking about the binder and the aluminum, the film.

A The only thing that is ~~contiguous~~ CONTINUOUS is the binder.

Q All right, so the binder ~~contiguously~~ CONTINUOUSLY covers --

A The nickel nucleus.

Q And in that binder, there are particles

of aluminum?

A Aluminum, yes, sir.

Q And in Fig 2, there is not a ~~contiguous~~ CONTINUOUS covering? And that is correct?

A No, sir, as far as I can see, Figure 2 shows a ~~contiguous~~ CONTINUOUS intimate contact, between nickel and aluminum, with no separation of any binder phase. We are looking at a small cross-section of the particle.

Q Fig. 2 here from here in the cross-section, is that covered?

A No, sir, no.

Q It's not covered?

A No, sir, because it's the end of a particle. There must be surface --

Q Then it's exposed?

A Yes, sir.

Q It is exposed?

A Right.

Q So there we have an exposed spot of nickel, and here the binder with the particle ~~contiguously~~ CONTINUOUS covering; that is correct?

A The binder ~~contiguously~~ CONTINUOUSLY covers, the aluminum does not.

Q I see. And you -- according to your testimony

and understanding, the 515 patent requires somehow that the aluminum contiguously covers the particle, because we used the word "clad", is that correct?

A Yes, sir. And in fact, your clad particle is the perfect example of that.

Q I am not talking about -- Isn't it true that the 404 is made by an entirely different method and has a different material on the outside? I am talking about the 450 material.

A Yes, but you also discussed a coating or a --

MR. CALIMAFDE: Just a moment. I object.

Stop, please.

He said he is talking about the 450 material, and there is nothing, your Honor, to support the statement that the 450 material corresponds to anything in the patent in suit.

Q All right, let's take the Exotec material, which as you testified, is made according to the procedure described in column five; is that correct?

A I think so, yes.

Q So it's your testimony then, as I understand it, that if you will follow this teaching of the patent how to make a clad particle, you won't get it, because to your understanding in accordance with the dictionary, clad means th

aluminum has to go all the way around; is that it?

A Yes, sir.

Q So according to your understanding, the teaching in the patent does not --

A It calls for a cladding or a coating.

Q And by following the procedure, you won't get it?

A You will not get a cladding or a coating.

Q Now, if I were an artist, and given this patent, and I did what it said, would I get a flame spray material?

MR. CALIMAFDE: What?

I object, your Honor, the question is much too vague.

Are you referring to an example, are you referring to the patent in toto? You are referring to what?

MR. SPRUNG: I am referring to column five.

THE WITNESS: You will get some sort of powder which is sprayable.

Q I see. Is it sprayable in accordance with the patent?

A What part of the patent?

MR. CALIMAFDE: You know, your Honor, column five does not give proportions, does not give sizes -- I beg your pardon, you have a 325 mesh. It does not

proportion and the question is, if someone made a powder in accordance with this column five, would he obtain something sprayable?

Is that the question?

Q All right, let's turn to example 31.

A All right.

Q Does example thirty one follow the general procedure as set forth at the top of column five, referring to nickel core and then aluminum paint.

A And specifically, it calls for 15 percent aluminum, eighty five percent nickel composition.

Q Then it's your testimony that by using fifteen percent aluminum instead of five percent aluminum, you are going to get a clad powder?

A No, sir, I didn't say that.

Q All right.

A All I said is that this follows what is in column 5, but it calls for a fifteen percent aluminum, eighty five percent nickel --

Q In your opinion, then, remembering your testimony as following column five, in your opinion, would you get a clad powder, by following example 31?

A No, sir, I do not call that a clad powder in the -- in the meaning of the --

Q I see.

A (Continuing)--patent.

* * *

Q 31, I'm sorry. Teaches how to make a self-bonding spray flame material having a nickel core and an aluminum paint on the outside?

A At the 85-15 composition.

Q Right, but that has nothing to do with the patent, according to you, you say, your interpretation, that wouldn't be a clad powder?

A I am sorry, all I said, that doesn't represent from what I have examined, a clad coated composite material.

* * *

Q What I -- you're testifying as an expert who had understanding of the patent. Does this teach you, does this example teach you how to make a self-bonding spray flame powder?

A 36 times in this patent the expression "A composite material composed of two metals."

Q Yes.

A -- "which react exothermically to form an intermetallic compound which -- in which the bond is what the patent tells me. This I don't know, except as being this kind of product, as being exothermically reacting, intermetallic-forming material. And this is why I am saying that-

Q I see. According to your understanding --

THE COURT: When you say this, you aren't referring to Metoc's, you're referring to the 95-5?

THE WITNESS: Yes, sir.

MR. SPRUNG: He's referring to example 31.

THE WITNESS: And I am referring to example 31 too. I don't know as that there is any intermetallic exothermal-forming reacting in that example.

THE COURT: In the 85-15?

THE WITNESS: Yes, sir. made by this technique. And for 36 -- 36-6 36 consecutive times the statement of the exothermal intermetallic-forming aspect is stated over and over and over again.

On the other hand, the expression, exothermal ic through oxidation is denied over and over again, and all I'm saying is that this material as a spray flame material does not react necessarily as an exothermal-forming material. It probably reacts as an oxid~~ized~~e-forming material.

THE COURT: Well, now when you say you don't know, does that imply, however, that it could be so?

THE WITNESS: Yes, because there are techniques to be used in -- in spraying which minimizes oxidation and such other things, and at the 15% level perhaps this is all right. I mean it would be stretching one's imagination to say yes, that's the way it would come out. I simply can't say that yes, it would come out that way.

THE COURT: I see.

THE WITNESS: And in the case of the 95-5 I can flatly say that it definitely would not

come out that way. So that's why I insisted on -- on reserving this for the 85-15.

* * *

Can you identify those as photographs that you took or were taken under your supervision?

A Yes.

Q Do you know which powder they were taken of?

A Yes. I am reasonably sure this is the Eutectic alloy, Exotec, and I am going by the presence of those aluminum particles on the surface.

Q Now, if I refer you to the top photograph of 63-C can you show me where the nickel is?

A Well, yes, you can see the nickel through --

Q I am talking about that --

A Well, it is the same particle enlarged. So one can see the nickel, the dark areas throughout the system. In other words you can look down in that -- for example that is a nicke area (indicating). All of those areas in between are nickel areas.

Q And the light areas are the aluminum?

A Yes.

Q Where are the binder areas?

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A The binder doesn't show up as a surface material.

If you look at the top of the picture you can see wher the binder is filling in. If you can look at the top you can see where it sinks in.

Q So, in other words, you have a sphere sort of, of nickel, and you have sort of little grains of aluminum surrounding it with binder in between the grains?

A Yes, binder between the grains and between the alumin and the nickel matrix.

Q Now, is it fair to say that the particle is coated with a film of some sort?

A Specifically it is coated with a film of the binder

Q Are coated or clad with the film of the binde

A Of the binder, yes.

Q And the binder has aluminum then dispersed

A Yes sir.

Q I see. Now, I refer you to example 31 agai of either ~~191~~ 515 or 248 patents, they are both the same.

Does that not define the material as a free flowing powder in which all of the nickel core particles clad with a dry film which consisted of aluminum particle bonded to each other and to the core material by the phen binder?

A No, it doesn't. The aluminum particles are not bo

to each other, and the aluminum particles are not bonded to the core material.

Q They are not bonded to each other?

A No sir.

Q I thought you said there was a binder in between the two --

A The language says that the aluminum particles are bonded to each other.

Q Right. Now, if I take two tennis balls and glue them together with a say quarter of an inch of resin between them, are they bonded to each other?

A With resin, yes sir.

Q Okay.

A They are not bonded to each other.

Q I thought you just said the tennis balls were bonded to each other?

A No, I didn't. I said they are bonded by the resin.

Q To each other by the resin. Isn't that semantic

A It certainly is. But it is very important semantics.

* * *

Q You can't figure that out?

Let me ask you this: Honestly, do you believe that this line is 5 weight percent or 5 atomic -- what is your best belief that this line is according to --

A If you would like to go there I can definie it for you precisely.

Q All right, let's go there and define it precisely.

A This line --

Q Yes.

A -- which designates the 95 weight percent --

Q Yes.

A -- nickel, 5%, weight percent, aluminum, represents the minimum of solid solubility. In terms of atomic percent it turns out to be very close to 90-10.

(Continued on the next page.)

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Q And so, would you conclude that the -- that in this chart the 90 shown, the point 9 shown is the atomic percent?

A Well, yes, now that we have corroborated this.

Q Okay, so that it's 5 weight percent -- right?

A We could have saved this had I been told what it was initially, instead of --

Q All right, so that's 5 weight percent, if we look at the charts below, we will generate 4,000 calories per gram atom, is that correct?

A With reference to room temperature, yes, sir.

* * *

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s,

MR. SPRUNG: Since we have had a speech, may I explain the witness has testified that past

this point you wouldn't get any heat evolved by the combination of aluminum and nickel. Clearly you had to have --

THE WITNESS: I most certainly did not.

Q Oh, you didn't testify --

A No, sir, I said, in an exothermically-forming reaction, and in a solid solution range, there is no exothermic forming reaction of the inter-metallic compound.

Q What is an exothermic reaction?

A A reaction which gives off heat.

Q Heat, all right.

When I combine nickel and aluminum in this range here, does it give off heat?

A Yes, sir, but it is not an exothermic inter-metallic forming compound -- reaction.

Q We differ on that, but let's -- Is it a reaction that results from the combination of nickel and aluminum?

A And is defined as a solid solution heat effect.

* * *

THE WITNESS: It is impossible scientifically to answer it any other way.

THE COURT: Well, let me ask you this: When you keep saying it is a solid solution of heat, what does that import?

THE WITNESS: Sir, we started out by talking about the 3000 calories. The 3000 calories comes about from the patent, which says that as the components, any two metals which may be melted together to form an inter-metallic compound in an exothermic reaction may be used, the components should release about 3000 calories per gram atom, and preferably at least 7000. That is what initiated the discussion.

THE COURT: Well, I understand that, but --

THE WITNESS: Now, the -- the heat which is being referred to here is a common factor in any system in which, when you dissolve one metal into another, if the two metals are sufficiently different, there will be a heat effect, which is due to the dissolving of one element into the other element, without the formation of any compounds.

THE COURT: What I commonly call the heat-plus aspect?

THE WITNESS: Yes, but it comes about from dissolving, and not forming exothermic inter-metallic compounds, which is what this addresses itself to.

THE COURT: I see.

THE WITNESS: And I cannot in any way change my testimony that the heat effect he is referring to is that due to a solid-solution effect.

* * *

that is, sir.

Q So your position is that when nickel and aluminum combine in less than 5 percent aluminum to form, say, a solid solution, or whatever you call it, of aluminum and nickel, no heat is generated?

A I'm just telling you that the reaction cannot take place in the way you are describing it, because when -- and we have run the experiments -- our calorimetric tests were exactly that, we took the material with 5 percent aluminum and 95 percent nickel and heated it.

Q Yes.

A And the first thing that happened when the aluminum melted was that we had a big decrease in temperature.

(continued on next page.)

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Q You always get -- even when you have more than five percent, you get it?

A Oh, yes, sir, right, you got a decrease in temperature.

Q And you got no peak?

A Then you have to regain that heat, and then there is a peak, and in an oxidizing atmosphere, I've already testified that that heat effect is strictly the heat of oxidation.

Q Okay, so if -- let's get back to that.

Now, we are taking what we call your -- to get back to realism, the 450 material ~~for~~ or the Exotec material, right? And we put it in a crucible and we heat it?

A Yes. sir.

Q We get up -- as we hit the melting point of aluminum we get a slight dip in temperature, then we get a peak in temperature, which you say is due to an oxidizing effect?

A An oxidizing atmosphere, yes.

* * *

Q While we are on this, while we are on these graphs, I believe you have testified that there were different rates of heating which you observed between the 4504 powder and the Exotec powder; is that correct?

A Oh, yes, that's what the curves show.

Q I see. So it's your testimony that one of the materials heats at a faster rate when the reaction proceeds than the other; is that correct?

A Yes, sir.

Q Which heats at a faster rate?

A The 95-5 heats at a faster rate because it reaches its peak at 700 degrees, after having been molten at 660 degrees.

Q Oh, I see. And that's your -- that to you means that it heats at a faster rate; is that correct?

A I most certainly think so, yes.

* * *

Q Right, but it establishes -- the furnace heat-- for the furnace to get between 700 and 800 degrees, it takes a certain amount of time -- right?

A The rate is the slope of the curve.

Q Okay, good. And what is the slope of this curve as compared with the slope of that curve?

A The slope of this curve --

Q I calculate them as being substantially

identical, and if you will put the two -- there are two scales that are the same, are there not?

A I contend you have no way from these two curves of calculating the heating rate from the curve.

* * *

Q Dr. Grant, if I have a nickel particle and a coating of, let's say, five percent aluminum on it, now let's suppose I start heating this particle. I reach a temperature, do I not, that the aluminum starts to melt?

A Yes, sir.

Q So I have molten aluminum. And then I reach a temperature, do I not, that this aluminum on the surface starts to react with the nickel on the surface?

A Yes, sir.

Q Now, if the amount of aluminum which is on the surface starts to react, it goes in and reacts and forms an interphase, does it not, which is rich in nickel and aluminum?

A To the extent that the aluminum is available, yes, sir.

Q Yes, okay.

Now --

A In the meantime, as it is doing it, it, its melting temperature of the mixture is going up?Q It's going up, and I'm getting an exothermic reaction on the surface, here; is

that correct?

A You are getting a small exothermic effect initially in the solution of nickel and aluminum.

Q Let me ask you this, Dr. Grant: If the nickel in the center is still solid, can I form initially an intermetallic compound on the surface of the nickel with the aluminum?

A Depends on the amount --

Q Is that theoretically possible?

A Yes, theoretically. It depends on the amount of time that's available for these things to happen.

Q So that according to your opinion, with five percent aluminum on the nickel surface, it is possible for the aluminum to start to react with the surface of the nickel exothermically and form into a metallic compound?

A Yes, it may form a thin film of it. Yes, sir.

Q And then as the particle melts, the aluminum will diffuse further, and probably the intermetallic will be lost?

A Yes, sir.

Q And so you wouldn't find it in the coating -- right?

A Certainly not.

Q But you would get a reaction between nickel and

aluminum forming an intermetallic compound; wouldn't you?

A Yes, a vanishingly small amount.

Q Right, generating heat?

A Yes, but not necessarily permanent heat.

Q And if the reaction formed Ni_3Al, you would get how many calories per gram atom?

A Well, I doubt that it would form Ni_3Al.

Q Well, say that it would form NiAl.

A It would not form NiAl.

Q You said that it can form an intermetallic compound?

A Yes.

Q Which one?

A Al_3Ni.

Q Okay; and how much heat would be generated?

A Of the order of 3,000 calories per gram atom -- I mean, per -- per mole.

Q And how much per gram atom?

A Oh, I don't know; it's a calculation that might be six -- 6,000 or 7,000 calories per gram atom.

Q 6,000 or 7,000 calories per gram atom.

Now, I notice in your testimony when you were referring to the reaction which you testified would occur in the Exotec material, you kept using the term, exclusively heat

of oxidation.

A Yes, sir.

Q The heat is exclusively that of oxidation of aluminum?

A Yes.

Q What makes you think it's exclusively?

A For the simple reason that the aluminum particles, unlike your picture, are not in contact with the aluminum; there is no evidence that those aluminum particles stay in contact with the nickel, and these aluminum particles being physically separated, as the photomicrographs show distinctly over and over again, are in space literally, and they react with the first source of reactible material, namely, the oxygen in the flame, and burn to aluminum oxide.

(continued on following page)

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Q I see. Then you are testifying, according to your understanding, that the particles of aluminum act as separate, discrete particles of aluminum, separate from the nickel; is that correct?

A Yes, sir, yes, sir.

* * *

A No, I say if there were contacts between the aluminum and the nickel on a probability basis, then ultimately that

would lead to a solid solution effect for the amount of aluminum that was there, and for the amount of aluminum which reacted with the nickel.

Q All right.

A That's all I'm saying.

Q In your opinion, does that occur in the 405 -- I'm sorry, 404 Material, and the Exotec Material.

A Now wait, I would rather you separate those two, because I have to give them two different answers.

Q You said they are the -- I'm sorry, my error. 450 and Exotec.

MR. CALIMAFDE: What's the question?

THE WITNESS: What is the question?

Q The question is, in your opinion, when you spray Exotec or 450, does aluminum go into solution in the nickel?

A Wherever there is contact between aluminum and nickel, with whatever the probability is that in the flame-spraying operation they do contact, to that extent there will be solid solutions formed between the nickel and the aluminum, yes, sir.

Q All right, so then if there is contact between the aluminum and the nickel, then we can have a reaction between the nickel and the aluminum?

A Yes, sir.

* * *

THE COURT: Yes, sir, the upper drawing, where the aluminum is bonded, coated, in the sense I have meant it all along.

THE WITNESS: Around the nickel particle, not the -- not the agglomerate with the random dispersion of aluminum particles around. There I have no way of knowing what the probability is for contact and impingement of one particle on the other, to give a reaction.

* * *

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Q Now, Doctor, is it possible for nickel to react with aluminum to form a nickel-aluminide and then for the nickel-aluminide to oxidize to form nickel oxide, aluminum oxide?

A Yes, it is. That probability is very much smaller because of a feature known as the activity or chemical potential of a system. As soon as the aluminum goes into solution or reacts to form intermetallic compounds, its availability, its activity, if you will, in scientific terms, is sharply decreased, so that the ersistance to oxidation is highly enhanced by the fact that it has changed from pure aluminum to an intermetallic phase.

For example, its melting temperature goes up vastly.

Q But the nickel-aluminide can oxidieze?

A Yes, sir, but very, very slowly. As a matter of fact, nickel-aluminide is famous because of its extreme oxidation resistance.

Q Is the oxidation resistant because it oxidizes?

A It forms a think highly adherent refractory oxide skin which protects the balance of the material from further oxidation.

Q So it does oxidize rather rapidly when you have free metallic nickel-aluminide, isn't that true?

A Oh, but the amount is vanishingly small.

Q I'm sorry.

A The amount is vanishingly small.

Q I'm not asking you any amounts. I said metallic nickel-aluminide does react very readily with oxygen, is that true; yes or no?

A Yes, sir, yes, sir.

* * *

Q Dr. Grant, in your testimony on direct and

cross you have been referring to certain heats, like 4,000 calories per gram atom; is it true that these heats are generally measured in an instrument?

A Well, yes.

Q A fairly standard-type of instrument?

A Yes, reasonably.

Q What do they call it?

A Well, there are calorimeters, there are reaction chambers, they -- yes, these are standard pieces of equipment utilized for these kinds of measurement.

Q Is it true that they are basically containers which will hold the heat without loss?

A Oh, there are losses but these can be calculated.

Q And in measuring these values you put the sample or specimen in one of these instruments at a reference temperature, say room temperature, is that correct?

A Sometimes.

Q And then you would heat the instrument up to well past the melting point somewhere -- to where the reactions occur, measure the amount of heat that you have put into do this, let the instrument cool down to the reference temperature, say room temperature, and then measure the amount of heat that's still in the instrument?

A That's one way of doing it.

Q Is that fairly standard?

A Well, that's one -- one standard way, yes.

Q And if you make such a measurement you say that the measurement is made at a reference temperatur, say, room temperature, is that correct?

A Not necessarily made at that temperature. Calculated at that.

Q Calculated. That's what I wanted to establish . As your value is down, what reference temperature that you --

A Yes, very much so.

Q What?

A Yes, very much so.

Q What's the reference temperature?

A Room temperature.

Q Room temperature. And what -- when we were referring to Defendant's Exhibit IL, the 298 degrees which you said was room temperature, that's the reference temperatu

A Yes, sir.

Q Is it not?

A Yes, sir.

* * *

MR. SPRUNG: Your Honor, the witness has

testified as to certain tests. He draws very startling conclusions from these tests.

MR. CALIMAFDE: Let's not use characterizing statements about startling conclusions. What do you want? We'll produce it for you if we have it. Let's not talk about startling conclusions. It's perfectly obvious --

MR. SPRUNG: What I would like is a detailed report as to all the tests that Dr. Grant conducted, on which he has based his conclusions.

MR. CALIMAFDE: Do you have them with you?

THE WITNESS: No sir, these are --

MR. CALIMAFDE: Where are they, at MIT?

THE WITNESS: These are at MIT.

MR. CALIMAFDE: Can you get them?

THE WITNESS: Oh, yes sir, sure.

MR. CALIMAFDE: Okay, we'll produce them.

* * *

Q Those are the only tests you conducted?

A The only calorimetric tests.

Q I'm not talking about calorimetric. The only tests?

A I'm sorry, the only calorimetric tests I conducted, and in addition I had analyses made.

Q No, you had analyses made?

A I said so earlier.

Q May we have the analysis tests, the reports and the methods by which they were taken?

A Yes.

THE COURT: They are here?

Q And you have done nothing else?

A No sir.

Q You haven't examined any coatings?

A Positively not.

MR. CALIMAFDE: When you say examined what are you referring to?

MR. SPRUNG: Sprayed coatings.

MR. CALIMAFDE: But when you say examined, examined means many things: Microscopic[illegible], electron microscope, photographically.

Q Yes, anything that you could report on?

A No sir.

Q You have not?

A No sir.

Q Have you seen the coatings produced by the Exotec material?

A No sir.

* * *

Q And so I believe, if I understand your testimony correctly, that you characterize Plaintiff's Exhibit 64 as an oxidation reaction because of the rapid rise up and the quick drop down?

A Yes, sir.

Q Is that correct?

Now, do you get that quick drop down --

A Yes, sir.

MR. CALIMAFDE: You didn't finish your question, "quick drop down" in what, Exhibit 65?

MR. SPRUNG: -- 65 to below the initial starting point?

Q Do you?

A Does it go below?

Q Yes.

A No, sir, it doesn't.

Q So it drops down and then there is a certain amount of heat and cooling off; is that right?

A Yes, to the extent of talking about something which is an order of a degree and a sample which is not controlled to a gnat's eyebrow since we're waiting out a certain amount of material and we don't know that the packing is not

Sa

exactly alike, I would not attempt to try to differentiate one degree differences and even two degrees differences among these materials because it would be absolutely insignificant.

* * *

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Q In other words, you had testified that the 450 and the exothermic material are essentially identical; is that correct?

A Yes sir.

Q And yet on your measurements you get twice the temperature rise on the 450 than you got on the exothermic material; is that correct?

A Yes.

Q How would you attribute that?

A ~~Vast~~ VARIOUS factors such as packing density, for example. One would be the small differences in the degree of looseness of the binder around the powder, how well packed the aluminum is

in the binder. These are the factors that deal with it.

Q And that could result for twice the difference of temperature rise?

A Yes. It did in fact.

* * *

Q Now, visually, what is the difference in appearance between the 80-20 and the 95-5?

A The Metco 80-20, the 404, shows the surface of the nickel -- this is the nickel-clad coating which exists around the aluminum particles so that we are looking in that case at the external appearances of the nickel surface after the cladding, coating operation.

In the Metco 95-5, or the 450 alloy, we are looking at a -- in the upper left-hand picture we're looking at nickel particles which have a loose agglomeration of nickel -- I am sorry, of aluminum powder in a binder around the nickel.

Q I see.

And this is a loose agglomeration of powder around the nickel?

A Yes, sir.

* * *

Q Is that a structurally integral unit?

A At room temperature?

Q Yes.

A Yes, sir.

Q I see it is a structural -- in other words --

THE COURT: What does "that" refer to?

MR. SPRUNG: We're talking about the individual granules of the 450 powder and the Exotec powder.

Q Each of those granules, at room temperature, is

a structurally integral unit; is that correct?

A Yes, they are integral.

Q Are they structurally integral?

A Yes, in the definition of structure, yes, sir,they are.

Q And they are not a mere mixture of nickel and aluminum components; is that right?

A Yes, they are a mere mixture of nickel and aluminum.

Q They are a mere mixture?

A Yes, sir.

Q I see.

In other words, you can at room temperature separate the nickel from the aluminum without structurally destroying the grounds?

A Why am I restricted to room temperature?

Q Let's talk at room temperature. I am talking about room temperature now.

Do you understand what I am --

A Yes, they are structurally removable. Yes, sir.

Q At room temperature?

A Yes, sir.

Q In other words, if you ordinarily handle them the aluminum --

A Oh, wait, I am sorry, you are setting another set of

conditions.

Are you talking about just ordinary handling with your hands?

Q No, what I am saying is you have a particle, is that correct, that has a nickel nucleus and it has aluminum stuck by means of a binder onto the surface?

A The binder is on the surface?

Q Yes, and the aluminum is stuck there on the binder, right?

A In the binder, yes, sir.

Q It's in the binder, okay. Now, is that considered in your opinion, a grain of flame spray material?

A Yes, sir.

Q All right, now if I took a knife or anything else,if I could get it that small,and broke the aluminum particles off, would I be destroying that grain?

A Yes, sir.

Q And it is not a simple mixture of aluminum powder and nickel powder?

A Yes, it is a simple mixture of aluminum powder and a binder around a nickel matrix.

* * *

Q Now, Dr. Grant, let us suppose that I take a grai of 450 powder or Exotec powder, which is the nickel, the glue or the binder, with the aluminum in it, and it has a nominal five percent by weight aluminum based on the nickel; is that correct?

A Yes, sir.

Q All right.

Now, let us suppose -- now I am talking hypothetically-- that I start heating this material so that the aluminum starts to melt and melts and comes in contact with the nickel surface.

A I dont know that it would.

(continued next page.)

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Q I'm not asking you if it would. I am asking you to assume that it does.

A I'm sorry, I cannot

MR. CALIMAFDE: I object, your Honor.

THE WITNESS: I absolutely cannot assume that.

Q All right.

A I absolutely cannot.

Q You cannot assume taking a particle and heating it in such a mannter that the aluminum would melt and flow over the nickel?

A You just put the binder in there. I'm sorry, I just don't see how -- what's happening --

Q Wouldn't the binder --

A -- what's happening to the binder. In the meantime as a function of the temperature the aluminum is oxidizing and has a very refractory impermeable aluminum oxide skin on it, and all I'm saying is that aluminum ox -- that aluminum particle is going to sit as an aluminum particle in an envelope of skin and that it will not even wet that nickel, absolutely impossible. Proven over and over and over again.

Q I see.

A In other words, I can take a nickel substrate and put

any amount of aluminum on it, tiny particles of it, and they will sit there as aluminum particles in an aluminum oxide skin.

Q I see, and you won't reach a temperature where that particle will start flowing into the nickel?

A In fact, you would probably oxidize and burn the aluminum long before that could ever happen. Absolutely.

* * *

Q At this 5% aluminum, 95% nickel is it possible theoretically possible, to get intermetallic compounds?

A Theoretically possible, practically impossible.

Q I am asking you is it theoretically -- in other words, this is right on the line?

A I don't know, I can't extrapolate to that effect. I say theoretically possible, practically impossible.

THE COURT: Let's -- let me have that once again, theoretically possible to do what?

THE WITNESS: Practically impossible.

THE COURT: I understand that, but theoretically possible to do what?

THE WITNESS: To get --

MR. SPRUNG: To get an intermetallic compound between nickel and aluminum with 5% aluminum.

THE WITNESS: The phasing diagram says flatly, absolutely no.

Q It does?

A Yes, sir.

Q Would you come to the phasing diagram. Where

-- what's the minimum amount of aluminum at which you could get an intermetallic compound?

A Anything over 5%.

Q Where do you base your 5%, show me the line?

A Well -

Q I want you to point out to me.

A Here is the 95-5 -- right? The reaction.

Q It's not this line, is it? It's over from this line, it's over --

A No, no, here it is, right there. It's one tiny little graph point over. The reaction is supposed to take place at the melting temperature of the aluminum. If I move across to the melting temperature of the aluminum, I am in the solid solution range exclusively at 95-5. That's what the phase diagram says.

Q You're almost on the line, right?

A Almost.

Q How much more aluminum would you require to get over into the line?

A Another one or two percent.

Q That much?

A Yes, sir.

* * *

Q All right, so would you expect that you would have a proportion of that powder that might have 6% aluminum?

A Yes, sir.

Q Okay. And would that portion -- and with 6% aluminum it's theoretically possible to have an intermetallic

compound?

A A vanishingly small amount and also you're assuming none of that aluminum has oxidized way before the reaction.

Q Now, when you say vanishing --

A Vanishingly small, yes, sir, something of the order of 1 or 2 or 3%, which would give no heat input whatsoever.

Q If I have 6% aluminum and the balance nickel --

A Yes, sir.

Q -- wouldn't I be right on the intermetallic line?

A No, sir. That's the limit of solubility. That has nothing to do with the intermetallic compound. That's the limit of the --

Q Doesn't it form at that line?

A In proportion to the quantities that the phasing diagram dictates.

Q I see.

A And that amount would be as I said earlier, vanishingly small.

Q What do you mean by vanishingly?

A Oh, one or two or three percent.

In other words, the heat effect would be --

Q Will you explain to the Court what you mean by vanish, you mean that it disappears?

A Yes, that, too.

Q Let's not get down to the particles. I am talking if I put six percent aluminum and nickel together, can I get an intermetallic compound?

A If you are talking about one particle, yes, sir.

Q Okay.

MR. CALIMAFDE: Okay. And another thing I want to make clear. Are you asking him about a particle that's coupled with some 6% aluminum on this nickel or are you talking about the particle as it arrives at a substrate with some known percentage of aluminum on that nickel?

MR. SPRUNG: I am talking if I can take --

THE WITNESS: One particle.

Q One particle and get an intermetallic compound.

MR. CALIMAFDE: But what, what are you talking about?

Q At 6%.

THE COURT: But my belief is, Mr. Sprung, -- I think we're getting back into infinitesmal particles again.

I under tood the doctor to say several times that these one might call them inter-metallic minute type exothermal reactions in the mass do not --

THE WITNESS: There is no net contribution.

THF COURT: -- change any -- that's right, that's --

THE WITNESS: There is no net contribution.

THE COURT: I mean that --

MR. SPRUNG: That's his testimony.

THE COURT: I understand you will do your best --

MR. SPRUNG: I understand that, all that is --

THE COURT: -- to try to show that to be otherwise, but that's what he said.

Q Well, let me ask you this, if I have -- if I just take the particle or mass and melt together 6% aluminum, the balance nickel, will I get an intermetallic compound?

A If you are talking about one isolated particle, yes, sir.

* * *

Q Can you tell me how many -- how many calories per gram atom of heat are developed when six percent aluminum reacts with nickel?

THE COURT: Can you do that, Doctor?

THE WITNESS: Yes. Provided I can give my answer completed.

THE COURT: Well, let me say this. Have you done that? Have you made such a --

THE WITNESS: No. But this is a very simple calculation to make. I have a large mass.

THE COURT: Right.

THE WITNESS: There is his hypothetical position of a reaction at the six percent level. The amount of inter-metallic phase which would form dictates -- positively dictates -- since he has established his system dictated by that phasing diagram, he will form perhaps one or two

percent of inter-metallic compound which will generate heat. At the rate given in those numbers 3500 per gram atom, that entire heat has to be distributed over that entire particle, which means the net contribution to the temperature of that particle is zero. That's the full answer.

MR. CALIMAFDE: Is that with the aluminum sitting directly on the nickel or separated by a binder.

THE WITNESS: Even worse if it's separated by a binder because there wouldn't be any reaction whatsoever.

MR. CALIMAFDE: That's what we are talking about, separated by a binder.

THE WITNESS: So the presence of that tiny amount of inter-metallic temperature does not affect the system exothermically.

* * *

Q Dr. Grant, do you know -- and if you don't, say so -- what the minimum amount of aluminum to nickel in a nickel aluminum flame-spray powder has to be to make the powder self-bonding?

A What kind of powder are we talking about?

Q Let's take the 404 with the nickel on the outside, aluminum in the inside. Do you have any opinion?

A To have a significant effect, it would have to be at least 10 percent aluminum before you have a significant contribution from an exothermic reaction material to forming an inter-metallic compound.

* * *

Q Dr. Grant, during your direct testimony you testified as to your understanding of the Maskiw patent, which is 3, 853, 403?

A Yes sir.

Q Now, in studying that patent do you see any specific mention of flame spraying?

A No sir. I see a reference to --

Q I'm asking you a specific -- and I think we'll move along --

A No sir.

Q You do not? There is a reference to powder metallurgy though, the use of composite metal powders made and

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used in metallurgy?

A Yes sir.

Q Other than flame spraying would you give us some other examples of powder metallurgy?

A Powder metallurgy is really extremely broad. It's used in preparing materials for pressing and sintering, for extrusion for paints. It in fact is used for shape-making generally, with the capability of going to any degree of density.

In fact powders are also extensively used for the extrusion and -- for extrusion and forging rolling. They are also used for brazing. They are also used for hard-facing. They are also used for -- well, many, many --

* * *

THE COURT: Well, my next question really is this, that would it be correct to include the art of flame spraying within the term powder metallurgy.

THE WITNESS: Yes sir. It's a very vital part of it.

THE COURT: It is?

THE WITNESS: In other words, the flame spraying industry relies on the availability and manufacture and sizing and characterizing of powders for its use.

THE COURT: I see. So powder metallurgy in its derivation really refers to the technique of powdering metals?

THE WITNESS: The -- the technique of powdering and utilizing.

THE COURT: Powdering and utilizing metals --

THE WITNESS: Yes sir.

THE COURT: -- in that form?

THE WITNESS: Yes sir.

THE COURT: All right.

* * *

Q Yes, that's what I mean, which examples does he list?

THE COURT: Well, are you referring to 5 and 6 of the patent, of the Maskiw patent?

MR. SPRUNG: Yes.

THE COURT: Yes, there's a little table.

MR. SPRUNG: Yes, there is an example.

THE COURT: Right.

THE WITNESS: Yes. Well, it's very clear. In this particular table he has selected iron, nickel, cobalt, chromium, molybdenum, copper, titanium carbide.

Q And those are specific examples of composites which he makes, is that correct?

A Yes, those are specific examples.

Q Does he give a specific example of a nickel-

aluminum composite?

A No, but he refers to specific --

Q Would you answer the question?

A No.

(Continued on next page.)

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Q He does not? Does he have a general listing of the types of metals which he can chemically plate or coat?

A Yes, sir.

Q Where does that list appear?

A It appears in several places, actually.

Q Where is the most comprehensive?

A Well, let's see, column 2, starting with line 13.

"One or more of the metals of the group, copper, silver, gold, beryllium, zinc, cadmium, boron, aluminum, indium, titanium, germanium, zirconium, tin, hafnium, lead, vanadium, mobrium, antimony, tantalum, bismuth, chromium, molybdenum, tungsten, manganese, iron, cobalt, nickel, ruthenium, rhodium, palladium, osmium, irridium, platinum, uranium and thorium."

Q I had counted 35.

A I haven't counted them. That's fair enough, a fair number.

Q And what types of metals can he use as a coating material?

A Predominantly because of the nature of the chemical bath which he produces, the plating metal would mostly commonly be nickel or cobalt or iron or copper.

Q Does he list those?

A I think so. I'm not --

Q I refer to -- if we can speed this up -- beginning on line 35 of column 2.

A That's C.

MR. CALIMAFDE: I think it's 36, column 2.

THE WITNESS: Yes, I'm just --

"Metal values which can be precipitated from an ammoniated solution by a reduction with a reducing gas at elevated temperatures and pressure are those of osmium, rhodium, ruthenium, gold, platinum, palladium, silver, copper, arsenic, tin, nickel and cobalt."

Q And I count 13 that you just read, isn't that right?

A Yes.

"Usually, however, these precipitating metals will"--

Q Just --

A Well, I'm sorry, I'm reading it all.

"usually, however, these precipitating metals will be of the grpup silver, copper, nickel and cobalt."

Q So of the broad group of composites he can make just exemplified inthis column I get 455 combinations, is

that right?

A I would guess that's right, yes.

* * *

Q Now, does Bradstreet mention in his patent at any point that his spray material the way he sprays it forms a self-bonding coating which can be used as a bonding layup for further spraymaterial?

A Well, if one looks at column 2--

Q I'm just asking, does he say that?

A Yes, sir.

Q Okay; would you point outwhere?

A He says in column 2, at the very top, "Spraying onto a metal surface such as that, there is good mechanical as well as possibly a chemical bond between the material of the coating and the underlying metal."

Q Okay.

A Chemical bond means alloy.

Q I see. In other words, when I alloy twometals together, I get a chemical bond?

A Yes, sir, absolutely.

Q I see. That's what it means to you.

Does that involve --

A Yes, sir.

Q What?

A Yes, it does.

* * *

THE COURT: I will sustain the objection as to the flame spray art for what it's worth, and you may consider the question applying to your knowledge of flame spray patents.

Are you familiar with the flame spray patents?

THE WITNESS: Other than these which are here?

Q Yes, other than these.

A A few, yes.

* * *

-- MR. SPRUNG:

Q I believe we finished our discussion on the Bradstreet patent when we broke for lunch, and I would like you to turn to patent No. 2943951, the Haglund patent. It's 2943951.

Is this problem -- I am sorry.

Is this patent directed to the problem of flame spraying molybdenum desilicide in order to have the particles stick together?

A Yes. It teaches the use of molybdenum desilicide, involving aluminum plus --

Q Well, the --

A I am sorry.

Q I was just asking you a question. Yes or no.

THE COURT: Just try to confine your answer to the question, doctor. I think counsel will probably -- will go ahead and your counsel will have an opportunity also to go over --

THE WITNESS: You want to read that back to me, please?

Q You will understand, I understand you have a lot more to say and I'm going to ask you. I am just trying to

establish -- would you like the question back?

A Yes, please.

(Record read.)

A Yes, sir.

Q Does the patentee point that molybdenum disilicide normally forms a film of silicon dioxide which prevents the individual particles from sticking to each other?

A Yes, sir.

Q And does the patent indicate that a way of solving this problem is to flame spray the molybdenum disilicide with aluminum, so that the aluminum may react with the silicon dioxide film, removing this film and avoiding this problem of the particles not sticking together when they are flame sprayed?

A Except it is broader than that.

Q Does it say that? We will get into that.

A Yes.

Q And additionally, the aluminum in doing this does react with the silicon dioxide; is that correct?

A Yes, sir.

Q Exothermically producing a little heat?

A Yes, sir.

* * *

Q I believe you testified that the patent did not use the word "self-bonding" but described bonding?

A Yes, sir.

Q And aside -- let's not look at the claims, but into the specification of the patent, prior to the claims, can you point out where there is any mention or description of

bonding?

A There isn't.

There isn't?

Now, where in the claim --

MR. CALIMAFDE: Excuse me, your Honor. May I direct the witness' attention to the column? Again, rather than commit ourselves with memory testing here.

THE COURT: Yes. What column is it?

MR. CALIMAFDE: It's column one, lines 64 through about 67. It's the sentence beginning on line 64.

THE WITNESS: Yes. Sorry.

"This action depends thereon that said oxides given intense reaction heat with aluminum whereby the reaction product adhering to the surface show an increased superficial activity."

BY MR. SPRUNG:

Q Where are we now?

A Column one, starting with line 64.

Q Does this describe what happens when the reaction products are on the surface?

A I presume it does.

Q I see.

Does it define how the product adheres to the surface?

A No, sir.

It says that the reaction product adheres to the surface.

Q It says that it adheres to the surface?

A Yes, sir.

* * *

Q Now, does that describe the bonding of the particles onto a surface, or the bonding of the particles together?

It says, "For adhesion together of said refractory component powder particles."

A No. It does say that. It does say to each other. But let's see. No. That's the only one.

Q I see.

And that goes with the teaching in the patent that the individual particles, when they are sprayed won't stick together because of this silicon dioxide film?

A Until aluminum is added, in which case, they will stick together.

Q Stick together.

Do you have any personal knowledge, if this material is self-bonding?

A No, sir.

Q Do you know if its commercially offered, to your knowledge, as a self-bonding material?

A No, sir.

* * *

Q Now, the patent in its preamble describes that a chemical plating -- strike preamble -- in its beginning, describes that a certain type of chemical plating process is known for nickel and in this process, you get certain spent material and stray plating, and the object of the patent is to utilize that material; is that correct?

A Yes. It can be used directly, too, but it happens that this is one of the ways it is used, yes, sir.

Q In other words, the object of the patent is to find one utilization for this spent plating material and stray plating?

A Yes, one.

Q One use.

The use that they find is by flame spraying; is that correct?

A Yes, sir.

Q Okay.

In other words, they take this material basically and grind it up and make a flame spray material out of it?

A Yes, sir.

Q Now, are you familiar whether the plating process is a commercial process, from which they get this spent material?

A It isn't now. It was used as a -- it has been used. The product was sold to be used as a flame spraying operation.

* * *

Q Now, how about -- is that any different thant the chemically deposited coatings by the Kanigen process?

A Not so far as I know. They can be made the same.

Q Do you know if the manufacturer calls those materials alloys?

A The unreacted material he does not call an alloy.

Q He doesn't.

I refer again to the brochure. What's the --

A I'm sorry. What is the date on the brochure? I thought we were -- I thought we were looking -- I'm sorry. I didn't know the date on this. This could be last week's.

This material was available at the time the patents were in contest. I have no idea what the date of that is. That could be 1973.

Q I'm not asking for the date. I'm just asking, you said that this describes the Kanigen process?

A Basically it does, yes.

Q In your opinion, does the article attempt to analyze what the plating is?

A Yes sir. It says in abstract, "A nickel deposit produced by the catalytic nickel reduction process, x-ray and electron diffraction revealed that the nickel deposit was in the amorphous solid."

It does not say nickel phosphorous. It says "the nickel deposit was an amorphous solid," which says that the nickel is there as nickel. Therefore, the phosphorous has to be there as phosphorous.

Q I refer -- what's an undercooled liquid?

A An undercooled liquid is one that has not crystallized in the process of cooling because of a thermal effect which prevents the arrangement of the atoms into a crystalline form. It therefore goes into a crystalline form either at a much lower temperature or at some subsequent reheating temperature.

Q Now, on page 109, the bottom to the last paragraph, the author says "One of the main questions regarding the nature of it as deposited metal is whether the structure is that of an undercooled liquid or a sub-microscopically fine grained super-saturated solid solution."

Is that correct?

A That's what he says, yes.

Q Yes.

Well, now, as an undercooled liquid, what would be the form of the phosphorous in that undercooled liquid?

A It would be deposited as discreet particles of phosphorous unalloyed.

Q I see.

It would not be in solution in the UNDER cooled liquid?

A A moot point as to whether you call it solution or not. I choose not to call it in solution.

Q You choose not to.

Do you know anyone in the art who would choose to call it in solution?

A Not anyone in the art but in the scientific field I don't know anyone who would call it that.

Q Could you separate the phosphorous out of this material?

A That has nothing to do with it.

Q What is the size of the phosphorous? I'm not asking if it has anything to do. I'm asking a question.

A It's an atomic or -- atomic in form or an atomic clusters.

Q I see.

So it's distributed in atomic form throughout or atomic clusters throughout?

A Yes sir.

Q This nickel?

A If it were a solution, then x-ray diffraction patterns

should show.

Q Please?

A Just a minute. I'm sorry. He's asking me to define whether it's a solid solution. I can't define it without defining what a solid solution is.

THE COURT: I see.

Q I didn't ask you that.

All I asked you is if you could separate it out?

A No sir, because it is impossible to separate anything out of an amorphous solution, out of an intermetallic compound, out of a solid solution or an atomically mixed system. It is impossible to do it in any of these cases.

Q So this is something more -- the distribution of the phosphorous in the nickel is something more intimate than you would normally get if you just had pieces of phosphorous?

A No. I would say is less intimate.

Q I see.

In other words, if you just mixed up pieces of phosphorous with nickel, you would have a more intimate mixture?

A No sir. I didn't say that either.

Q Well, then wait until I finish my question.

THE COURT: I think Mr. Sprung and the Court are confused.

THE WITNESS: He wouldn't let me answer the

early question of what's involved here. You know what -- may I?

THE COURT: All right. Go ahead.

THE WITNESS: If I take an element such as nickel, if I dissolve phosphorous or aluminum or silicon or vanadium or any other metal. Those two atom sizes are not the same. So when one goes in to the structure of the other, it automatically either expands or contracts that lattice. That is, the nickel atoms are arranged, it would -- near perfect periodicity. In other words, it's repeated over and over and over again.

Now, as you add more of a larger or a smaller element, such as phosphorous, the dimensions of this structure change, and it's very easy to measure the dimensions of that structure to a billionth of an inch. You measure it in angstroms.

It's very possible to do this, and the point is that if it is a solid solution, then one should be able to measure this as a change in the size of the structure.

But that's not what you find.

You find instead that the nickel has not changed its structure, so this is my reason for

saying that it is not a solution.

Furthermore, when that process is reacted, it then does form the intermetallic compound, NI3P, which is easily recognized. It has its own diffraction pattern and there is no -- no ambiguity about this.

But an amorphous system is not necessarily a solid solution.

The other complication, of course, is that when particles get finer and finer and finer, the diffraction pattern is a bit more and more difficult to interpret and this is -- I don't know -- just one of those facts of life that I don't know how to explain to a Court in detail.

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Q Would you classify this material from your understanding as a rather unique structure?

A Yes.

Q Do you know of any other material that has this structure available?

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A Yes, but not in this context.

THE COURT: One which has perfect uniformity of molecular structure?

THE WITNESS: No. Of atomic structure. The distribution of the atoms is not in clusters. It is not in chaotic disarrays. It is uniformly dispersed throughout, again with the same periodicity.

Q Does aluminum and nickel make this type of system? Form this type of system?

A No sir.

Q It does not?

Now, the author takes this rather unique material and describes experiments where it is heated and he gets a rise in temperature. Is that correct?

A Yes sir.

Q And he concludes from that rise of temperature that it is an undercooled liquid rather than a fine grained super saturated solid solution; is that correct?

A Yes, that's what he says.

Q Now, that heat, is that a heat of chrystallization that he's measuring or heat of fusion?

A No, it's not a heat of fusion.

Q Well, heat of chrystallization and fusion are

the same, aren't they? Same number of -- I'm asking you?

A No sir.

Q No, they are not?

A No, not necessarily.

Q What is it, a heated chrystallization?

A A heat of transformation if you will.

Q I see.

It's a heat of transformation?

A Yes. I think that's the only proper term for it.

Q That's -- the nickel is not in chrystalline form?

A To start with.

Q And as -- because it's frozen by the chemical process in this rather ~~hard~~ ODD form?

A Yes sir.

Q And when you heat it, it releases and it rearranges to its normal chrystal form?

A Yes sir.

Q And the phosphorous comes in this chrystal structure; right?

A Yes sir.

Q Depending on its composition?

A Right.

* * *

Q That's how much it contains, but I'm going down a little further.

A And then you say content of the composition is about 11 percent.

Q All right. So that if you have -- does the -- that subsequent portion tells us that if we have less than 11 percent phosphorous when we heat this material, that we will get nickel crystals in a eutectic matrix and if we have an excess of phosphorous and we get NI3P, super-saturating bath; is that correct?

A No sir.

Q Isn't that what it says?

A Not quite.

Q Tell me quite?

A Well, it says the melt -- this is talking about -- upon subsequent cooling, the melt begins super-saturated with nickel in the event the phosphorous content of the

composition is below 11 percent, whereas upon subsequent cooling the melt becomes super-saturated with NI3P nickel phosphide, in the event the phosphorous content of the composition is above 11 percent. But in both instances you have nickel plus nickel phosphide. It's the relative amounts of the two which are really being defined here.

Q Would you read -- I read that it says specifically, in the event -- a little above that?

A Yes. Line 9.

Q Upon --

A In the event the --

Q "In the event that cooling the melt to the eutectic temperature of 880 degrees c, considerable solid nickel is present in the solution of the eutectic mixture, so that upon further cooling of the mass, the solid nickel is productive of primary nickel crystals, in the mass of the eutectic composition, that appears as substantially nickel dendrites in the eutectic matrix."

A Yes, but that tells you nothing about the proportions of these. The phase diagram tells you what the proportions are.

Q And then it says "If you have an excess of phosphorous, it becomes super-saturated with NI3P."

A Yes.

Q That was my question.

A Yes. That standard phase diagram and the point is that at one position you have NI3P. That is the midpoint, when your composition is composed of one atom of phosphorous and three atoms of nickel.

If you have a little bit more phosphorous then this, you will have NI3P as the excess phase.

If you have a little bit less then that, you will have some primary nickel, and the amount of primary nickel depends on the phosphorous composition. It goes down to zero when you reach zero phosphorous.

I mean, this is no different than the nickel aluminum diagram that we looked at. It is exactly the same phase diagram structure.

* * *

Q The manuscript -- I refer to the last page on 110.

MR. CALIMAFDE: Thank you.

THE COURT: What is this, now?

MR. SPRUNG: What?

THE COURT: Which?

MR. SPRUNG: Of the article.

THE COURT: One-ten of the article?

MR. SPRUNG: Yes. Page 110.

THE COURT: All right.

BY MR. SPRUNG:

Q It says, "Manuscript received March 14, 1956." And the application was filed on April 16, 1957; is that correct?

A That's what it says, yes, sir.

Q All right. So that the article was obviously written before the patent application was filed; right?

A Before it was filed, yes.

* * *

BY MR. SPRUNG:

Q In other words, the patentee says he simply takes this material and grinds it up and sprays it; is that correct?

A Yes, sir.

Q And that's the substance of the process that he follows; right?

A Yes, sir.

Q All right.

Is there any statement in the patent that on spraying this material, heat is generated by an exothermic reaction?

A Not in the patent, but the article covers it.

Q All right.

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Q Doctor, we were discussing the Gutzeit reference, United States Patent 2,908,589, yesterday?

A Yes, sir.

Q Now, it was my understanding from your direct testimony that it was your opinion that the Gutzeit material if flame-sprayed would be self-bonding, is that correct?

A Yes.

Q And would you point out the main portion of the patent on which you would base this belief?

A Well, Column 7 speaks well -- Column 7, line 16.

Q What is the characteristic on column 7 and line 16 which leads you to believe that the material would be self-bonding?

A Well, as I read it it says, "The phosphorus therefore reacts as a deoxidizing agent, resulting in the capability of the molten droplets or globules to wet most metals, even

though they are coated with a think, unwetable oxide skin." Most oxides, normally to prevent wetting, the nickel oxide -- the phrase, "does bond and does wet." Wetting to me means strictly alloying or -- or welding.

Q I see. So according to your understanding a flame spray material which would have this characteristic of wetting the surface on which it is sprayed would be a self-bonding material?

A Yes, sir.

Q Is that correct?

A Yes, sir.

Q And doctor, I believe you testified that aluminum had this characteristic, is this correct?

A Yes, sir.

Q In other words, if I would spray aluminum it would wet the surface?

A Under the proper circumstances, yes, sir.

Q And you believe that would be self-bonding?

A Yes, sir, I think it can be.

Q Will you tell us any other metals which have this characteristic which would be self-bonding in your --

A Yes, sir, I think the material disclosed in the Montgomery patent.

Q No, I'm just asking any metals per se.

A I'm sorry, that is a nickel plus magnesium oxide. It contains metal.

Q No, may I rephrase that question. Do you know -- we'll get to that -- do you know of any metals per se, other than aluminum -- and I'm not talking about alloys, I guess my terminology was not too clear -- just plain metals other than alloys which would have this characteristic and thus be self-bonding?

A No, aluminum I think is a perfectly fine, adequate example.

Q I see. Do you know how long aluminum has been used in the flame-spray industry?

A Many, many years.

Q As long as you have familiarity with it?

A Yes, aluminum has been used for flame spraying.

Q Now, what alloy other than -- I won't say other than, what alloys do you believe would be self-bonding when sprayed?

A Alloys containing aluminum. This would include cobalt aluminum, iron aluminum, nickel aluminum would be -- would be self-bonding if properly done.

Q And can you tell us of any other alloys or metals? Are you familiar with the self-fluxing nickel base alloys which we spoke about used in the flame-spray weld

processes? I believe they are alloys of nickel, cobalt and boron.

A And silicon, yes, sir.

Q Yes, would they be self-bonding?

A I think they can be self-bonding, yes.

Q I believe you testified that the Gutzeit material you had information was commercially sold at one time as a flame spray --

A Yes.

Q (Continuing) -- material, is that correct?

Is this personal knowledge, or would you give us the basis of this information?

A No, I -- I told you yesterday that I couldn't give you the details of it.

Q You just have a general knowledge? That's understandable.

A I'm aware that it was used.

Q What?

A I'm aware that it was used, yes. I don't know to what extent.

Q Do you know if it was ever promoted as a self-bonding material?

A No, sir, I don't.

Q Do you know if it was ever listed in any

handbooks or any publications as a self-bonding material?

A No, sir.

Q Is nickel a material which has this ability of wetting a surface to make it self-bonding?

A Under certain circumstances, it could be, yes, sir.

Q Under what circumstances?

A Oh, proper flame conditions, non-oxidizing atmosphere, proper -- proper surface cleanliness, yes, it would --

Q Well, what if I just took nickel and an ordinary flame-spray gun as we know it --

A I'm sorry, that's not what you asked me.

Q This is a new question, Doctor. I say what if we take nickel and an ordinary flame-spray gun, oxyacetylene gun, the thermal spray gun -- Are you familiar with the thermal spray gun?

A Yes, sir.

Q The thermal spray gun, and spray it onto a very clean, smooth surface; would it bond?

A No, sir, probably not.

Q How about aluminum? That would?

A Yes, sir, under proper circumstances aluminum would.

Q And you could spray another material over it and use it as a bonding coat?

A Possibly not, no. No, because there now -- there now

would be an oxide skin on top of that coat.

Q Now, what about if I took the Gutzeit. Let's take a steel plate, clean steel plate, very clean, smooth ground, and take the Gutzeit material and a good oxyacetylene powder flame-spray gun and spray it on that surface; in your opinion, would that self-bond to the surface?

A Yes, sir.

Q It would? Now, what if I took steel and sprayed it over the Gutzeit material; would that bond the steel to the steel substrate?

A Possibly, yes.

Q I see. That would bond -- in other words, my over-layer of steel then would be bonded to the substrate?

A It could be if it's hot enough, the flame spray conditions are right, yes, sir.

Q And so that would be in your opinion a good commercial self-bonding material?

A Oh, I didn't say that.

Q You didn't say that?

A No.

Q How would it compare with molybdenum in your opinion?

A How would that compare with molybdenum?

Q The Gutzeit material?

A So far as I know, it would bond equally well.

Q I believe you testified that in accordance with your understanding a self-bonding material, what is considered in the flame spray art as a self-bonding material, is a material that bonds to a clean, mild steel surface or steel surface with about 2,000 pounds?

A I don't think there is any magic any 2,000. I think if it stuck with a thousand that would be fine for application, if it stuck with 5,000 it would be finer. I don't see anything magic about the 2,000 or the 3,000.

Q I'm talking about what's recognized in the flame spray. Do you know according to your understanding about 2,000 in the trade?

A Yes, we went through that two or three times.

Q Well, what bond strenth do you think the Gutzeit material might have?

A I have no idea. I didn't spray it.

Q What is your understanding of a bonding coat in the flame spray field?

A A bonding coat is one which will weld to the surface, which will be wetted to the surface, will be alloyed to the surface and therefore will stick.

Q And what's its use in the flame spray field for a bonding coat? Have you heard the term bonding material?

A Yes, I have heard the term bonding material. Yes, sir.

Q I believe you testified you knew about

molybdenum. What's the purpose of it?

A Well, it can be put on as a coating of its own or it can be used as an undercoating for something else to be put on.

Q I see when it's used --

A I -- the same material can be used either way.

Q I see when it's used as an undercoating then it's used to bond the final coating to the substrate, is that correct?

A Yes, sir.

* * *

Q All right, let's get back to Schwayder. This patent teaches the coating of tungsten carbide particles with nickel, is that correct?

A Yes, completely coated with nickel or with a nickel nickel nickel phosphate.

Q What do you mean completely coated?

A Well, that's what it says.

Q Well, that's what I want, what's your under-

standing of completely coated?

A Meaning that the tungsten carbide particle is completely coated with the nickel or with the nickel nickel phosphide material.

Q I see.

A That's what it says.

Q I see. Well, what if he just said, "Coated?"

A I'm sorry, he says, "Completely coated." Line 53, column one. This -- "These objectives are achieved by completely coating the tungsten carbide particles with nickel or with nickel nickel phosphide."

Q And you place significance on that "completely coated?"

A Yes, sir.

Q And in your understanding with the nickel coated tungsten carbide spray be a self-bonding material?

A Well, he says so, he says in column one, line 66, "Tungsten carbide raw material and then surface coating the particles" -- I am just trying to find my location here. I'm sorry, if you can hang on for a moment. I think I missed my line there.

MR. CALIMAFDE: May I direct the witness's attention to column three, the first oh, about 6, 7 lines and also column one, line

about -- the paragraph beginning with line 48, line 48, column one.

Q I didn't hear it. So would you tell me the columns and read them for me?

A Well, column 1, line 48 says "In addition it is the object of this invention to treat the tungsten carbide particles by surface coating them with nickel or nickel nickel phosphides so they become wettable or welded and may be braced to the work piece surface." But I'm sorry, that's not the one I'm looking for. I'm sorry.

(Continued on the next page.)

Q Is that -- well --

A That's not the one I'm looking for.

Q Does that indicate to you self-bonding, that portion?

A Yes, sir. The one I am looking for is the one where it says the coating dissolves into the iron.

Q All right.

A Well, I am sorry. It's there. If I have time, sir, I can find it.

Q Yes.

THE COURT: A little below that.

Q I just want to question you about the first sentence.

THE COURT: Line 52.

Q You said the tungsten becomes wettable and --

A No, that isn't the one I'm looking for. I'm looking for the statement that says it dissolves into iron.

THE COURT: Column 1, line 55.

THE WITNESS: Yes. I'm sorry. There it is.

"These objectives are achieved by completely coating the tungsten carbide particles with nickel or with nickel-nickel phosphide. This coating acts as a sacrificial material

which evaporates, oxidizes, and also dissolves in iron."

And that to me is an absolutely bit of evidence of bonding, self-bonding.

Q I see. So it's your understanding of this patent that this would produce a self-bonding material?

A Yes, sir. That's what it says right here.

Q I see. Let's go back to your first sentence. You believe that a material if it becomes wettable and may be welded or brazed to the work surface, it would be a self-bondable material?

A Yes, sir.

* * *

Q So they incorporated a refractory high melting insulating material in a metal which is generally lower metal melting; is that correct?

A Yes, sir.

Q That is sprayed to let it stick to a base; is that correct?

A Yes, sir.

Q And that is applied with a -- it says a powder weld oxyacetylene powder gun? I am referring to column 3, line 44.

A Yes, that's right.

Q And, again, in column 5, about line 5 or 6, "Powder weld acetylene flame powder gun;" is that right?

A Yes, sir.

Q And it's your understanding that this material is self-bonding; is that correct?

A Yes, sir. And the reason -- if you look at column 5, line 6 to 15, it says: "The metal surface to be flame-sprayed was cleaned and roughened by grit blasting, using a sharp and fairly coarse silica sand or silicone-carbide

grit. The coating was applied by the same technique as used for flame spraying metal powders, which is well known to the art. The coating is accomplished without undue heating of the target (the metal part being coated). The temperature attained by the target is controlled by the distance from the gun to the target. Just enough heat is used to alloy a given coating to a given metal base."

That's why I say self-bonding.

Q What?

A That is why I say it's self-bonding because it is alloyed to the surface.

Q It is not your understanding that you apply heat with this powder weld gun, enough heat so that the alloying occurs?

A No, sir. It says the metal part being coated is cold without undue heat, which to me means a very, very small amount of incidental heat from the spraying operation

Q I see.

A It specifically states that.

THE COURT: Now, when you say a given coating, do you consider that it is an alloyed or alloying process when the coating is of a ceramic nature?

THE WITNESS: No, sir. This particular

material is a composite material, composed of metal plus oxides. So in a true sense it is a composite which is -- the oxide is within the metal coating. And that metal-like coating to which can be added nickel, cobalt, iron and their alloys. So there is lots of metal there. And the alloys, you will note, include nickel, cobalt, aluminum and their alloys. And that is the bonding phase. It specifically states that it is, "to alloy."

* * *

Q So that this is -- in order to achieve the purpose

of spraying he makes a composite wire of the two ~~emiscible~~ IMMISCIBLE metals; is that correct?

A Yes, sir.

Q And just sprays it though with the standard wire gun?

A Sometimes with aluminum flux.

Q And does it spray with aluminum flux?

A No. Not jointly.

Q And is it your understanding that this material is self-bonding?

A Yes. From -- reading again, if I may, page 3, line 25, "heated to a temperature such that the particles of the metal are welded to each other and to the plate."

Q O.K. Now, does this patent relate at all to the powder metallurgy field?

A No, sir.

Q But it is directed to flame spraying?

A Well, it's the wire technique rather than the powder technique.

* * *

Grant-cross

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Q I see. I am talking about -- have we covered

all the patents which you believe relate to the flame spraying?

A Well, I am wondering -- I wonder if I took a quick look at Herz and Grala -- Herz is not a flame spray operation, but it does disclose the nickel aluminum composite material, but not flame spraying.

Q How about --

A Grala is also not flame spraying, but again, simply discloses the aspect of nickel aluminum being an intermetallic exothermic reacting material.

THE COURT: Ditto.

THE WITNESS: Yes, ditto.

Q So, Dr. Grant, we have covered a number of patents relating to flame spraying specifically, have we?

A Yes.

Q Bradstreet, Haglund, Montgomery --

A Gutzeit.

Q Did I miss any?

A Schraeder.

Q Schraeder; and all of these patents disclose self-bonding flame spraying material; is that correct?

A Yes. Their language tells me --

Q No. Is that correct?

A That's correct.

Q We don't need --

THE COURT: All right.

Q And what is the common feature of all these references, if there is any, that makes their material self-bonding?

A Well, for one thing, many of them disclose the use of aluminum to oxide and thereby generate a large amount of exothermic heat, which permits then, the material to become powder, to become plastic and molten, and at high velocity to impinge upon a substrate and thereby adhere and to weld, and to alloy.

Q Which ones disclose that?

A The Montgomery discloses that.

Q Montgomery discloses the use of aluminum for the purpose according to your understanding.

A Well, it certainly oxidizes.

Q Do you mean --

A There's no way to avoid the oxidation. It's in an oxidizing flame. It will oxidize and generate heat. And does weld.

Q Let me ask you as to these, would any of them be any more self-bonding than aluminum itself?

A Yes, they could be.

Q What additional reaction would be involved and would be involved if you spray aluminum itself?

A It's not the additional reaction. It's the fact that you are concerned with perhaps the amount of oxide that you generate along with the process. And if you had other materials there, particularly if you were looking at it as a substrate, you would have less oxidation potential than nickel or cobalt would be. And in any superior coating, has something better to stick to it. It's a two-step operation.

Q So that it is the common feature of all these patents which make them self-bonding; is that correct?

A Yes. It's one of them.

* * *

Q Doctor, if you would explain about this com-

feature, it would --

A Well, I said one of the common features of these, is the presence of aluminum, which during oxidation in the oxidizing flame, generates additional heat, and this provides for the particles to -- powder particles to become plastic and molten, and thereby, to enhance their ability to weld or to alloy to the substrate.

In addition, as a second feature, the aluminum can act as a flux, and can be oxidized the subsurface of the substrate thereby also making it easier for the powder to weld and to alloy to the substrate.

These are two common features of many of these.

Q Doctor, when you say flux, do you mean their wetting characteristics?

A No, sir. I don't mean that at all. I mean the ability of aluminum, for example, or phosphorus, for example, or silicone, for example.

Since it has a very high affinity for oxygen to strike the substrate which will have an oxidized film on it. And the oxidized film is the thing that presents welding or bonding. And the purpose of the strong reacting element such as aluminum and phosphorus or silicone, is indeed, to reduce that oxidize to flux it, namely, to convert it into a -- instead of a film, flux it into a fine particle. And it frees

the substrate then of any interference and makes welding for bonding much easier.

Q Does that occur on different types of surfaces or only specialized surfaces?

A Any kind of surface.

Q In other words, if I took aluminum and sprayed it on nickel, it would do that?

A It could.

Q Are there any other features common to these patents that make them self-bonding?

A No. I think we have covered them, the exothermic reaction, the fluxing reaction.

Q That's what makes them self-bonding?

A Yes.

Q That's what these patents teach to you?

A Yes, sir.

Q I see. So if you read these patents as a [illegible] what they teach to you is that if you would take the aluminum and let it externally react by burning, it will make a self-bonding material; is that correct?

A It certainly helps in that respect. Yes, sir.

Q Well --

A It will give it self-bonding characteristics.

Q That's your understanding of the teaching of the

patents?

A Yes.

THE COURT: Well, maybe it would help a little, to ask this. Do I understand that the net of this is that the aluminum is the critical element here, which serves a dual function?

THE WITNESS: Yes, sir.

THE COURT: Is that it?

THE WITNESS: Yes.

THE COURT: Putting it in the nutshell?

THE WITNESS: Yes, sir.

* * *

Q What does he say?

A He simply says there are problems encountered in making these materials.

But the exothermic reaction, while a critical part of it, isn't the reason that the material is no good. Nickel aluminide NIAL, is a brittle material.

Q But this has nothing to do with the exothermic reaction?

A Yes, it does.

It teaches the fact that nickel and aluminum combined in this way, will ~~externally~~ thermically react to form an intermetallic compound. That's all it attempts.

* * *

THE WITNESS: Yes, sir.

It's included in this patent to demonstrate that it was well-known in the prior art, that nickel and aluminum, in proper proportions when reacting would generate large amounts of heat, forming the intermetallic compound.

(Continued on next page.)

go to 593

Q Does it solve this problem by allowing the reaction between the nickel and aluminum to occur in a very

specific manner with the nickel and the aluminum in a very specific form?

A Yes sir.

Q Okay.

A "forming the nickel in small discreet shapes, forming the aluminum in pieces each larger than each of said nickel chips, placing the nickel chips and aluminum pieces in an induction furnace in contiguous overlying layers, introducing an inert atmosphere into said furnace at a pressure in excess of atmospheric --"

Q What do you mean by inert?

THE COURT: You will help me if you give me the column and the line.

THE WITNESS: This is column 5. It's the single claim patent.

THE COURT: I see.

THE WITNESS: Yes, he gets his reaction by making sure that his nickel and aluminum are in good contact with each other.

Q In a specific form large chips and layers?

A I don't care. As long as they are in good contact.

MR. CALIMAFDE: Your Honor, the only claim asserted against us in the process patent, the 248 patent, says not a word about self-bonding.

MR. SPRUNG: It doesn't matter. The result -- we will brief that, too.

MR. CALIMAFDE: It talks about this new, allegedly new, material.

MR. SPRUNG: We teach how to do it, and

the results are inherent.

MR. CALIMAFDE: Oh, is that right?

MR. SPRUNG: That's right.

MR. CALIMAFDE: You're getting all this down, Mr. Reporter?

That's another reason why it's invalid, if the result is inherent. But your Honor, apart from all that, this only claim about which we've heard a new result, this allegedly new result of self-bonding, which is an expression adopted by the patent owner, does not appear in the only claim asserted against us. The process calls for --

* * *

Q How does he solve these problems?

A By taking nickel and aluminum and zirconium, by compacting these intimately and reacting them to obtain an exothermic heat of reaction of the intermetallic compound which is formed to produce an intermediate product which is then subsequently crushed and prepared for powder for subsequent hot pressing, sintering.

Q If the ultimate powder is reacted powder of aluminum and zirconium?

A Yes sir.

Q Now, does he solve his alloy problem mainly by the incorporation of zirconium?

A He adds zirconium. I don't know how well he solves his problem. I don't see any significant numbers in his product which tells me what results he got with his material.

Q You know how much zirconium he adds?

A Up to 7 percent. He lists a number of composition ranges, but they're all between 2 and 7 percent on average.

Q Did I understand your testimony on direct that

he made a composite flame spray powder?

A No, he made a composite powder which was used for sintering and hot pressing, but certainly could be used for spraying.

Q Would you point out where the powder which could be used for spraying --

A I didn't say that. I said "And which." He prepared a powder for metallurgy which could be used for spraying.

Q That's what I want you to point out. Where in the patent is this powder which could be used for spraying?

A He produces the powder. He does not use it for spraying.

Q I say where does he produce; show me in the patent where he produces the powder which, in your opinion, could be used for flame spraying?

A The conglomerate -- I'm sorry, column 3 line 65, "The conglomerate is then crushed into a powder such as minus 100 mesh particle size and the powder body size is further reduced in size as by ball milling in a tungsten carbide mill under a cover of a suitable protective liquid until the particles of the conglomerate have been reduced to a size of 2 to 5 microns or minus 325 mesh particle size." These powders are, obviously, suitable for powder spraying.

Q Fine. What is the composition of these powders?

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A Nickel aluminum in a metallic composition containing up to 7 percent zirconium alloyed to the nickel aluminum intermetallic.

Q The nickel aluminide has already formed in the powder; is that correct?

A Yes sir.

Q If you spray that powder, would it be exothermically reactable?

A I never said that.

Q I'm not asking you.

A No sir.

Q It would not?

A No sir.

THE COURT: This is not exothermic?

THE WITNESS: It had already gone through the exothermic reaction.

THE COURT: Before it became powder?

THE WITNESS: Yes sir.

Q So, it's a pre-reacted powder that you would be flame spraying?

A Yes sir.

Q Would that be self-bonding?

A I think it could be, yes sir.

Q Have you studied the Shephard patent 2585417

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A No sir.

Q You have no familiarity with that?

A No sir.

Q I forgot one. Hensel patent. Does that disclose a flame spraying material?

A No sir.

Q What does that disclose?

A Just a minute. I'll be right with you.

Q Give us a quick summary.

A It represents, discusses a composite powder in which particles of powders of tungsten and molybdenum are individually coated with platinum, palidium and such precious metals,

In other words, it is there primarily to discuss the production of a coated composite powder.

Q How do they form the coated composite powder?

A That's in here, too. I'm reading the first page, column 2, "The protective coating of rhodium, platinum, palidium, may be applied by any one of several methods such as electro-plating, cathode sputtering, metallic spraying, condensing evaporated metal on the particle surfaces, chemical deposition."

Q That's what you are citing that for?

A Yes sir.

Q Is there any other coating similar between the

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Hansel patent and the way coated powders are made?

A They may also be coated by first coating the powder with a dispersive adhesive, then dusting the adhesive coated particles with the protective metals in powder form and subsequently heating the coated powders to disperse the adhesive in diffusing the protective metal into the surfaces of the refractory powder.

* * *

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Q Dr. Grant, at the conclusion of your direct testimony you were good enough to make plaintiff's exhibit 69. Did you draw that?

A Yes sir.

Q In which you compared Metco 404 with, I believe, the Exotec material marked 29904; is that correct?

A Yes sir.

Q Would you be prepared to prepare a similar chart for me comparing the Exotec material with the material of example 31 of the 515 patent?

You mean you want the whole vertical column?

Q Just the same way as you have done in connection with 404 and 29904?

A Do you want me to draw it?

Q I would appreciate it very much.

(Witness leaves stand; complies with Mr.

Sprung's request.)

A Since I do not have to draw it twice, may I draw a parallel to it?

THE COURT: Fine, that's all right.

MR. SPRUNG: Fine.

(Continued on next page.)

2next

Q Let me ask you first, the Metco 450 would be identical to this; is that correct (indicating)?

A Yes, sir.

Q Would you write on that Metco 450.

A (Witness complies.)

Q We're talking about Example 31 (515) patent.

A Nickel nucleus as before (indicating).

Q What's the significance?

A But now with 15 percent aluminum instead of 5 percent aluminum in resin varnish incorporated; and, therefore, if we are assuming Example 31 started out with the same size nickel nucleus as before, you would simply increase by a factor, perhaps, 3 -- not quite 3. The thickness of the varnish coating containing the particles, so instead of having the thin coating I have indicated here, you would have a thicker layer of conglomerate of the varnish containing the aluminum particles, but again, I must assume not ever having seen a product made according to Example 31, that there would be no contact between the aluminum particles to each other directly and no contact of the aluminum particles directly onto the nickel nucleus.

As I say, this has to be prefaced by the fact I have not seen No. 31, but I have seen the 451 alloy and I have also seen the Exotec alloy.

THE COURT: So I am clear, you mean by your actually having seen the others and your position, they are not in contact, you assume, this condition prevails here?

THE WITNESS: This example 31 is supposedly described by the same method as has been used by making up the previous.

MR. SPRUNG: Let's give this an exhibit number (indicating).

THE CLERK: So marked as Defendant's Exhibit K and N. So marked as one photograph marked for Identification as Defendant's Exhibit KN.

MR. CALIMAFDE: May I see it?

(Exhibit handed to Mr. Calimafde.)

Q Dr. Grant, I hand you Exhibit KN and ask you assume that this was a cross-sectional photo of the material of the example 31.

A All right.

MR. CALIMAFDE: I am not sure I have prepared my witness --

MR. SPRUNG: I'm assuming it.

THE COURT: I thought KN was the exhibit number given to this chart. Am I mistaken in

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that?

THE WITNESS: You haven't given this.

MR. SPRUNG: We haven't given this.

A What's the magnification on that?

Q 400.

(Exhibit handed to the witness.)

MR. CALIMAFDE: Your Honor, I'm going to object to this exhibit unless it's properly identified and authenticated.

MR. SPRUNG: Well --

THE COURT: I'll take it subject to connection.

MR. SPRUNG: I see nothing wrong with asking him to assume something and then if the assumption proves nil --

THE COURT: All right.

A So that the nickel particle, according to Exhibit K[illegible] is it?

Q Yes.

A Nickel particles are larger than they are in the previous figures that I showed where the particle size was of the order of 60 to 70 microns. If these photographs are correct, these photographs are more like 75 to 100 microns, so these nickel nuclei are almost twice as big to start with.

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So, in this respect, he is showing me material which has a different nickel nucleus and the previous two materials.

MR. CALIMAFDE: Different in diameter?

THE WITNESS: Yes, sir, which means the surface area also, obviously, must be different, too.

Q Go ahead. I'm asking in general.

A I don't apologize for my artwork. I would say my artwork still stands.

Q You have a circle around the outside of this (indicating). You don't have it here. What's that?

A I'm sorry; I have a dotted curve.

Q Why don't you draw them, unless there's some special difference?

A I'm sorry. I didn't attempt to do any artwork here. I didn't attempt to show the precise position --

THE COURT: You're dotted line represented the perimeter?

Q The solid line indicates the perimeter here?

A Essentially, I made no attempt to draw this artistically or precisely.

THE COURT: Very well.

Q Since this kind of a particle --

THE WITNESS: Since this kind of particle

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in an oxidizing stream would undergo oxidation of the aluminum particles to give me aluminum oxide, I will assume that my temperature increase, delta T and the function of the temperature would still give me a reaction which would look more or less like this (indicating), in which I would expect that the maximum peak would be achieved at 700 C, which is the characteristic trademark for that particular oxidation reaction and that the temperature would fall off, more or less, just as rapidly as it rose to some level approximately similar to the initial level, because this would be a relatively violent operation in which now you would be burning almost three times as much; essentially three times as much aluminum as you did in the 295 material.

The temperature level would go, obviously, to a higher quantity.

Q Doctor, what is the nil?

A Meaning no significant -- no increase in here over the prior level (indicating), to which I will attach any significance.

Q Would you write "nil," there then?

A Nil (witness complies).

Q What's the significance?

A The other one is nothing more than the burning reaction. Now, I have the aluminum particles dispersed initially and unevenly and not always completely coating; that is, not being completely in the varnish coat around the particle, that there would be gaps of this sort, to draw it; and in the high velocity and the high temperature reaction, these aluminum particles tend to separate from the particle, from the nickel particle and oxidize according to this reaction (indicating), to give me the exothermic heat of oxidation, not inter-metallic formation. And since the nickel particles and aluminum particles are not in contact, I must assume that there would be no important contribution of an exothermic inter-metallic forming reaction, except on the probability that maybe some impacts on a collision course between these particles.

To that extent, I don't know what would happen.

THE COURT: Do I understand you to say, even with respect to oxidation, however, that would be exothermic, but not inter-metallic?

THE WITNESS: Not inter-metallic. The patent probably says it must be inter-metallic exothermic reaction. It denies there is or can be any oxidation exothermic reaction. They don't

want an exothermic oxidation reaction. That is specifically ruled out within the patent.

THE COURT: In your opinion, you say there is an exothermic oxidation reaction?

THE WITNESS: Yes, sir, I'm sure.

Q Will you follow the teaching of Example 31 of the patent?

A No, there's nothing spelled out there in Example 31 that tells me there's going to be a heat of oxidation.

Q It tells you how to make and spray a material. You are saying when this occurs, this is what happens; is that correct?

A That's what I am proposing as to what would happen.

Q What is this Delta H?

A That's the exothermic. In other words, minus Delta H, equal to the Delta thermic oxidation reaction.

Q Both of these then are quite similar; is that correct; except for the quantity of aluminum?

A Yes, essentially. Unless, there's a small amount of inter-metallic formation, which I have no way of judging, because I don't know what the probability of contact between the nickel and aluminum would be in flight. I don't know.

Q We didn't understand that from your previous testimony, Doctor.

A All right.

Q In your opinion, would the Exotec and the Metco 450 give a self-bonding flame-spraying coating?

A Yes.

Q As would Example 31?

A Yes.

THE COURT: Doctor, did I understand you yesterday to say that you would, could get this inter-metallic compound if you have as much as one or two percent over five?

THE WITNESS: Practically, unimportant.

THE COURT: You're talking in terms of a fleeting?

THE WITNESS: Yes, this is a smidgeon of it, which you dilute it into the volume of the reaction product, is not a measurable significant product.

THE COURT: To get what you consider inter-metallic composition, would you have to require a greater percentage of aluminum or would it be more intimate contact --

THE WITNESS: Both. By my attitude, you would have to have at least 10 percent aluminum.

THE COURT: Here you have 15.

THE WITNESS: Yes, I'm saying you would have to have at least 10 percent before you can begin expecting from the face diagram that you should get it. Then, if you fulfill the requirement of making sure the aluminum and nickel do come in contact, then you can get it, to the extent it exceeds the solubility limits.

(Continued on next page.)

MR. SPRUNG: M I, I'm sorry. MI. May we label this MI?

THE COURT: So this is defendant's exhibit MI. All right.

Q Doctor, from the method described in example 31 would you expect to get a structure which looks like 29, 904 and Metco 450 except for this extra quantity of aluminum?

A The -- What is the exhibit number?

Q I'm not talking about the photographs. I'm just reading example 31.

A Yes.

Q Would in your opinion you get a material that looked like the material you got in the Exotec Metco 450 except for the larger quantity of --

A You specified 15 percent in 31?

Q Yes. I'm asking you --

A Shall we say similar, yes.

Q Except -- In other words, they should be the same except for the larger quantity of --

A That's what I'm saying, similar.

* * *

REDIRECT EXAMINATION

BY MR. CALIMAFDE:

Q Doctor Grant, I show you Plaintiff's Exhibit 72 for identification, entitled "Powder Metallurgy" -- Well, the Exhibit consists of a cover page, and page 29, and I'll ask whether you have seen that cover page and page 29 previously?

A Yes, sir.

Q Will you briefly describe what it is?

A Well, it was a book that was published by Professor -- edited rather, by Professor John Wolf of M.I.T., published by the American Society for Metals, having to do with the broad topic of powder metallurgy in connection with a conference that was held at M.I.T.

And page 29 deals with powders and powder products, specifically surface coatings produced from metal powders, and including metal-spray guns.

Q Now I'll ask you to look at Plaintiff's Exhibit 73, which again has a copy of the cover page, and several pages which are part of that publication, and ask whether you can identify it?

A Yes, sir, this is from Volume III, which is one of four volumes in a series of books entitled "Treatise on Powder Metallurgy" by Dr. Klaus Gatzel, having to do, again, with

the broad aspects of powder metallurgy, and including as an integral part, that of spraying.

Q Thank you, Dr. Grant.

Does the Gutzeit Patent disclose a composite?

A Yes, sir.

Q Is it a composite for flame-spraying?

A Yes, sir.

Q Is the composite a structurally integral composite?

A Yes, sir.

Q Is the composite nickel?

A Yes, sir.

Q And phosphorus?

A Yes, sir.

Q When the powder is flame-sprayed, will there be a reaction between the nickel and phosphorus?

A Yes, sir.

Q What is the nature of that reaction?

A It's the formation of the inter-metallic compound Ni3P, and associated with that reaction is a heat evolution.

Q Is that an exothermic reaction?

A Yes, sir.

Q Is that what we've been referring to as an exothermic reaction?

A Yes, sir, it's an exothermic reaction.

Q Now, how does the exothermic reaction of Gutzeit compare with the exothermic reaction described in the 515 patent?

A Only that one is the formation of the nickel phosphide inter-metallic, and the other is the formation of the nickel aluminide intermetallic.

Q What is the difference between the composition in the Gutzeit patent, as compared to the 515 Patent?

A Again, the only difference is that in the one case the phosphide -- the inter-metallic is based on phosphide, in the other case it's based on aluminide. In both cases, inter-metallic compounds.

Q What does the patent of Schwayder -- Do you have that before you? -- What does the patent of Schwayder disclose in the context of a nickel phosphide?

A It discloses a coating of a nickel phosphide integrally on a tungsten carbide particle.

Q Does the patent to Maskiw disclose a composite?

A Yes, sir, it discloses a whole series of composites. Yes, sir.

Q Is one of the series a nickel-aluminum composite?

A Yes, sir.

Q In your opinion, would it be obvious to one

skilled in the powder metallurgy art to substitute the composite of Maskiw for the composite of Gutzeit?

A Yes, sir.

Q If one made the substitution of starting materials, how would the process and sprayed coating in the Gutzeit Patent, compare with the process and sprayed coating of the 515 Patent?

A It would be the same.

Q Would anything more be required than a mere substitution of the starting material to duplicate the process, and sprayed coating of the 515 Patent?

A No, sir.

Q Now, there is some testimony regarding the tests or analysis which you conducted at M.I.T. Did you conduct any analysis of any tests, or was any analysis or test performed under your supervision, which produced a result at variance with the testimony you have given?

A No, sir.

Q Now, in connection with your cross-examination, you were asked whether any examples specified in the Maskiw Patent, any of the expressed or explicit examples in the Maskiw Patent, corresponded to the composition in the 515 Patent.

Now I would like to ask you whether there is any example in the 515 Patent which corresponds to the composition in the

accused Exotec powder?

A No, sir.

Q Now, Maskiw discloses a series of metals or materials for coating, and a series of metals for the core. In your opinion, how many of those metals for the coating and core are commercially practical combinations?

A Very few. Nickel, cobalt and iron would probably be the three most common ones that anyone would seek for the kinds of applications these materials are used to -- used for.

Q Now let me direct your attention for a moment to the Phase Diagram, which is Plaintiff's Exhibit 66-A. Now, is it correct, Dr. Grant, that the Phase Diagram represents the nature of the alloy at various temperatures, which is dependent upon the proportion of the nickel to aluminum?

A Yes, sir.

Q Does that represent the proportions in the alloyed or molten stage, does that Phase Diagram represent them in the -- No, strike the question. I am sorry.

Let me address myself to flame-spraying: If we now consider flame-spraying, to understand the alloy, the composition of the alloy as it exists at the substrate, isn't it true that we must understand the proportions of the nickel and aluminum in the molten globule as it arrived at the substrate?

A Yes, sir, this is a dynamic system, and while one injects

a powder composition into the flame, which is one composition, what arrives at the substrate can be an extremely different composition.

Q So that the fact that a powder contains 5 percent aluminum and 95 percent nickel does not tell us the condition--

MR. SPRUNG: Your Honor --

MR. CALIMAFDE: Strike that.

MR. SPRUNG: (continuing) -- these are leading questions. I don't mind him leading the witness, but this is direct examination.

THE COURT: All right.

MR. CALIMAFDE: Yes.

Q Doctor Grant, taking into account the flame-spray temperature and the melting point of the aluminum, and considering the flame-spray operation, in a powder particle which has 5 percent aluminum on the surface, like in the accused products, what percentage of that aluminum would arrive at the substrate?

A A vanishingly small amount, because the aluminum begins to melt at a relatively low temperature compared to the flame temperature, begins burning rapidly at temperatures as low as 660 degrees centigrade at a time when the flame temperature is many, many hundreds of degrees hotter, and during this short interval of flight, because of the high heat of oxidation that

is present, the reaction is very rapid, and most of that aluminum will burn away, so that the material arriving at the ~~interface~~ surface may be something very much closer to pure nickel, being relatively low in aluminum content.

Q Is it misleading, therefore, to look at this Diagram PX-66-A when discussing the particle as it arrives at the substrate in terms of 5 percent of aluminum?

A That represents an equilibrium condition for the compositions, and not the reaction product that arrives at the interface.

Q Well, talking about the reaction products, which means --

THE COURT: Translated in my language, that does not reflect it as it arrives at the substrate?

THE WITNESS: Yes, sir.

THE COURT: All right.

THE WITNESS: Sorry.

THE COURT: Okay, no.

Q Which way would it be when it arrives at the substrate?

A Well --

Q Would it be further in the direction of pure aluminum, or would it be further in the direction of --

A Since -- Since the element that is being consumed by oxidation is aluminum --

Q What element is being consumed?

A Since the element that is being consumed by oxidation is aluminum, obviously the aluminum is being used up, and the composition moves more toward that of pure nickel.

Q So that the sense of this Exhibit 66-A, we are talking about the particle having a position to the right, is that correct, and the sense of this Diagram would have an aluminum content, which is further to the right?

A Yes, sir.

(continued on next page.)

REDIRECT EXAMINATION

BY MR. CALIMAFDE:

Q Let me discuss this subject of heat of solution with you just briefly in language that perhaps I understand.

Is the heat of solution a physical reaction that occurs between any two components when one melts into the other?

A Yes, sir. There is always a thermal change. There is always a heat change. It will vary in magnitude depending on the characteristics of the two elements involved, but there is always an energy change, a heat change, when any two elements react so that one dissolves into the other.

Q Now, is this reaction peculiar to nickel and aluminum?

A No, sir. It exists -- this exists across the board for all binary, ternary; in other words, two element, three element and four element reactions.

Q Do the materials which are disclosed in the prior patents in Plaintiff's Ehxibit 7 also undergo a heat of solution?

A Yes, sir.

MR. SPRUNG: Object to the -- when, when

they are flame sprayed or --

MR. CALIMAFDE: I think -- you are going to make an objection?

MR. SPRUNG: Yes, sir.

MR. CALIMAFDE: What is it, what is the objection?

Q When it undergoes the heat process which is described in each of the respective prior patents, will the materials undergo or evolve a heat of solution?

A When they react with each other to form a solid solution, there will be a heat of solution from this reaction.

Q So this is just a normal natural phenomenon; isn't it?

A Yes, sir.

Q That applies to all materials?

A Yes, sir.

Q Does the heat of solution require a physical contact between the elements?

A Yes, sir. They must alloy in order for that reaction to occur.

Q Would there be a heat of solution with the 80-20 patented powder?

A No, sir.

Q The one with the nickel on the outside plated over the aluminum, the aluminum core, 80-20 alloy.

A 404.

Q That's the 404, yes.

Would there be a heat of solution when that undergoes the exposure of the flame?

A Simultaneously, again, as we have described in the past, if there is a small reaction interface, there is a small reaction zone in which this also will occur in a small way.

Q Well, I'm now talking about the 404, which has the nickel plated over the aluminum.

A Yes.

Q All right.

Is there a significant or measurable heat of solution where there is a physical spacing or separation between the two components?

A There can't be unless one dissolves into the other.

Q Would it occur in the accused Exotec powder?

A No, sir, I don't believe it will.

Q Is the heat of solution either expressly disclosed or implicitly disclosed in the 515 patent as contributing to the reaction between the metal components?

A No, sir. The words are not at all mentioned

anywhere in the text.

Q Does the heat of solution produce an intermetallic compound?

A No, sir.

Q Does it result from an intermetallic compound?

A No.

Q Is it in any way associated with an intermetallic compound?

A No, sir.

Q Now, let me discuss the aluminum reaction with you for a moment.

Since, according to your testimony in the accused powder, the aluminum does not react with the nickel to generate heat, what does the aluminum react with to generate heat?

A The aluminum first sees oxygen when it reaches its melting point and because the driving force, the chemical potential, the chemical reaction of the oxidation reaction is so much greater than any other reaction, that is the first opportunity offered for reaction, it is the first reaction that must take place. Therefore, there is -- there is an exothermic heat of oxidation due to the oxidation of aluminum in the oxidizing atmosphere

of the flame.

Q Now, let me refer briefly to Column 5 of the Bradstreet patent, beginning at line 36. Column 5, line 36.

Do you have that, doctor?

A Column 5, line 36.

Q Yes, sir, "Still another technique."

Do you see that?

A Yes, "Still another technique which is effective to raise the temperature of the particles in the flame is that of adding a material to the composition while undergoing an exothermic reaction while in the flame."

Q All right.

Now, what is the nature of that exothermic reaction?

A It is an oxidation reaction.

Q What is the nature of the exothermic reaction in the accused powder?

A It is an oxidation reaction.

Q Is there a difference between the oxidation reaction described in the Bradstreet patent and the oxidation reaction which the accused powder undergoes?

A No, sir.

Q Let me ask you this, doctor:

Will aluminum plus any flame spray powder generate heat during spraying which aids in the bonding of the powder to the substrate?

A Yes, sir.

Q Is that knowledge disclosed in the prior art?

A Yes, sir.

Q In your opinion, which is the most pertinent patent in the book of prior patents?

A Gutzeit. Gutzeit combined with -- with the article.

Q In your cross-examination you were asked with regard to many of these prior patents whether there was mention of a surface preparation prior to the spraying of the flamespray powder.

A Yes, sir.

Q Do you recall that?

A Yes, sir.

Q In reviewing the 515 patent in suit, and sepcifically the examples, is there mention in the patent in suit anything regarding the surface preparation of the substrate?

A Yes, indeed. My analysis of the total reading the patent indicates that there were 13 claims which show the use of emery cloth, light grit blasting, grit blasting

grinding and sand blasting.

Q You said claims, I think you meant examples.

A Examples. There is apparently a lack of confidence in self-bonding here because I see examples such as the following and I am quoting --

Q Which one sir, which example?

A Well, let's see, Example 1 calls for emery cloth roughing.

Example 5 calls for light grit blasting.

Example 6 calls for preparation by grit blasting.

Example 7 calls for preparation by grit blasting.

Examples 11, 12, 13 and 14 call for preparation of the substrate by light grit plasting.

Examples 16, 17 and 18 call for preparation by grit blasting.

19 and 21, surface cleaned by grinding or a very light sand blast cleaning.

(Continued on next page.)

8 Grant - redirect

Q All right. I think that's adequate, doctor.

You were shown this photograph by Mr. Sprung, which is Exhibit KN, and Mr. Sprung suggested that we assume this was a photograph of an 85-15 powder.

Ir looking at that powder, in your opinion, is that a coated nickel core?

A No, it is not coated with aluminum.

Q Now, in the example which -- example 31, which apparently is illustrated by a sketch --

THE COURT: May I interrupt for just a moment?

MR. CALIMAFDE: Sure.

THE COURT: That answer is based on your -- I don't want to say belief, but at least your position that it is because the particles are imbedded in a binder?

THE WITNESS: Yes, sir, the particles are not in contact with each other or not in contact with the nucleus, yes, sir.

THE COURT: That is to say, when you say not coated, you mean because there isn't an actual contact?

THE WITNESS: And also no continuity. In fact --

9 Grant - redirect

THE COURT: And no continuity?

THE WITNESS: In fact this -- this photomicrograph shows some of the particles to be half bare of any aluminum.

BY MR. CALIMAFDE:

Q Perhaps you can show that to the Court, doctor, where there is an absence --

A Specifically this particle has only a little bit of aluminum and all the rest is empty. This particle, that whole area is empty. So that these are --

THE COURT: But of course, I don't know whether reference was made -- Mr. Sprung, would this photo be cross-sectional?

THE WITNESS: Yes, sir.

THE COURT: 2-b?

MR. SPRUNG: And it was -- well, we'll explain, when you polish it, you --

THE COURT: When you say empty, you mean down here? You are not referring to the face of the cross-section, obviously.

MR. CALIMAFDE: Excuse me.

THE COURT: When you say the aluminum particles are not down here, meaning this is the surface of the --

10 Grant - redirect

THE WITNESS: Yes, sir, the perimeter --

THE COURT: You are not referring to this interior --

THE COURT: No, that's solid nickel.

THE COURT: It's cross-sectional.

THE WITNESS. Right, that is a solid cross-section of the nickel nucleus.

THE COURT: Say over here, for example.

THE WITNESS: Yes, outside of the nickel nucleus in this cross-sectional view, there are no aluminum particles?

MR. SPRUNG: Is that resin around the --

THE WITNESS: Yes, sir. There is a resin, yes, sir.

MR. SPRUNG: Coating the particle?

THE WITNESS: The resin coats the particle, yes, sir.

BY MR. CALIMAFDE:

Q Looking at this particle, which is the second from the right in the photo, your statement that the aluminum does not cover the particle, is this what you are referring to, a surface such as this, which doesn't seem to have --

A Yes, sir.

Q (Continuing) -- any aluminum particles?

A Completely free of any aluminum particles in its proximity.

Q And is that what you base your opinion on that it is not coated?

A Yes, sir.

Q Now, in the Example 31, Iidentified as Defendant's Exhibit MI, you indicated -- well, I won't try to paraphrase what you did testify to, Dr. Grant.

In your opinion, would there be an intermetallic exothermic reaction when you have 85-15 nickel and aluminum with the aluminum particles being located on the outside --

A Well --

Q (Continuing) -- around the nickel core?

A Well, why don't we say located as they are in this photomicrograph.

Q Right, in a binder in a phenolic binder around the core, and these aluminum particles appear to be in clusters in that binder.

A Yes, sir.

Q Would you have in the particle which had a proportion 85 nickel, 15 per cent aluminum and exothermic intermetallic reaction?

A That's a probability function. The five per cent aluminum alloy doesn't permit it at all because the five per cent aluminum is less than the quantity necessary to form any intermetallic.

When you get to 15 per cent, you are very close to the composition of the full intermetallic and that, of course, would have formed had you had intimate contact between all of the aluminum and all of the nickel.

But since these aluminum particles are largely dispersed and randomly dispersed, in many cases not anywhere near the nickel particle, the probability -- and this is all you can go by -- that an intermetallic form depends entirely on the spraying action and the number of collisions that one might have between the nickel and aluminum particles in flight.

Now, that probability is difficult to gauge as a pure guess, because I don't know what the flight characteristics would be.

I would anticipate that the -- in fact, I -- I would be sure that the oxidation reaction would occur and however much rises at the surface of the interface for further reaction, I have no way of guessing. That probability is purely a probability. That it can occur, yes. That it may not occur, yes.

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Q The only thing you can say with certainty in 955 proportions you will not have intermetallic --

A Yes, that statement I would make affirmative.

* * *

Q Dr. Grant, I believe you testified that according to your opinion in the Gutzeit patent the phosphorous during spraying will react with the nickel to form an intermetallic compound generating heat?

A Yes.

Q Is that on the basis that you believe that the materials would be self-bonding?

A Yes, sir. That's one of the reasons.

Q It is on that basis that you are going to get this heat generation and heat bonding to substitute the aluminum for the phosphorous in Gutzeit?

A Yes, sir.

Q And could you make a Gutzeit material with aluminum?

A You mean manufacture it?

Q Yes.

A No, sir.

Q Now, you have testified that what has -- what occurs when these particles are flame sprayed such as the Eutectic material, the material according to example 1 -- the Metco 404 material, the Metco 450 -- I just want to make certain -- this is your opinion what you speculate would happen; is that correct?

A Yes, sir.

Q You have never seen it sprayed, you have never examined the coating?

A Yes, sir.

Q And you do speculate that in this example 31 there might be a possibility of aluminum contacting the nickel?

A In flight?

Q Yes.

A Yes.

Q Is there also a possibility in the Eutectic that some aluminum might contact the nickel in flight?

A Yes, if I have to put a percentage --

Q I am not asking you that.

A I'm sorry, I cannot answer then.

Q Is there a possibility, yes or no.

MR. CALIMAFDE: Objection.

Q If you cannot answer the question, tell me.

A Vanishingly small.

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Q In other words --

THE COURT: This was during the reaction?

THE WITNESS: Yes.

Q I am asking if in the 404 or Metco material there is a possibility that the aluminum will contact the nickel?

A I don't think you mean that statement.

Q What?

A I do not think you mean that statement.

Q Yes.

A No, you said 404.

Q 450.

A That's what I meant, 450.

Q Yes, is there a possibility that the aluminum particles will contact --

A My honest answer is very small.

Q There is a much larger possibility in example 31 because there is more aluminum?

A Yes, volumetrically nine times more.

Q If you start off with these particles, say of nickel, as you have shown here, with the probability to contact with the nickel greater -- the particles closest to the core?

A In flight, yes sir.

* * *

Q Would you give us a brief resume of your professional background?

A I worked for General Electric a total of 23 years. 11 of those years were spent at the Atomic Power Laboratory, 11 years spent at the Research Development Center, my title there was Research Associate and I was a supervisor of x-ray metallography.

In that capacity, most of my work was alloy development and analysis.

Q Following General Electric --

A After that I worked for the Fulham Corporation 3 and a half years now.

Q While working at General Electric, did you work with others?

A Yes, I was very closely related to a number of scientists there. At least 90 percent of them had PhD's.

* * *

Q Did there come a time when you received a request from someone at Eutectic Corporation to perform some analysis of some coating?

A Yes, we had an initial inquiry. It was in December of 1971 about analyzing some flame spray powder and the inquiry covered two questions. One was to determine whether there was any inter-metallic compound in this flame sprayed coating and the other request was in regard to some lead and chrome distribution in the flame sprayed material.

* * *

Q Following this letter was anything else received from Eutectic?

A Yes, I believe it was on January 17th that we received three samples which had a flame spray coating and we were to analyze the samples for one, the nickel-aluminum inter-metallic compounds and also -- we weren't told there was any in it -- any aluminum-nickel oxide, and aluminum oxide.

Q What was the form of these samples?

A They were in plate form. I think something like four inches by three inches.

Q They were coated plates?

A Yes. And we took sections out for analysis.

Q At that time did you know what they were coated with or how the coatings were formed?

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A No, we didn't get that information in the communication.

Q Who at Fullam performed the analysis requested in PX9?

A I did. There were two separate requests. In regard to the oxides and the aluminoides and elements, I performed this by X-ray refraction.

* * *

Q Is this technique accepted in the industry as standard for analyzing nickel aluminoide?

A It is a standard technique for analyzing any material, not specifically for this nickel aluminoid. You can identify any materials.

Q As a result of the work you did on Sample 1, what were the results and conclusions that you reached with respect to the composition of the coating?

A On Sample 1 we first performed the X-ray diffraction analysis with a diffractometer. That is an instrument that reflects X-rays off the surface. We at that time only found nickel. Then we put it into the scanning electron microscope

and we found some spherical or overall particles. They were analyzed with the X-ray energy analyzer. That is another instrument that is attached to the scanning microscope, and we found that these particles were primarily aluminum.

Our next step was to scrape the surface with a tungsten bar tool to take off a very thin layer and we analyzed it and we found some gamma-aluminum oxide in additional to the aluminum.

Q Did your analysis reveal any nickel aluminide?

A No, we did not detect any at all.

Q Did you subsequently prepare a report on your findings and your tests?

A Yes. This is our usual procedure. We submitted a report to the client.

THE CLERK: Letter and report marked for Identification as Plaintiff's Exhibit 10.

Q I hand you what has just been marked for Identification as Plaintiff's Exhibit 10 and I ask you whether you can identify it.

A Yes, this is my report and my signature.

Q This is a report that you prepared following the test?

A This is the covering letter and this is the body of our report.

Table 1 is the X-ray data and Table 2 has the microprobe data.

Q Would you in language that we can understand describe what appears on Table 1 of your report, Exhibit 10?

A Yes. In Table 1 on the extreme left, under the column where it says "observed," this is the data that we received from the sample -- the X-ray diffraction pattern.

Column 2, there where we have nickel it shows the match of the nickel spectra -- the known nickel spectra with the unknown material.

In the next column we have -- it shows the three strongest lines of this material, which identifies it with the three weak lines in the pattern. That is just a direct match to show that all the lines observed in the X-ray spectra -- the known X-ray spectra was identified.

(Continued on next page.)

Q Is that what you based your findings on, the coating contained nickel and gamma ~~nickel~~ aluminide oxide --

A If there was nickel aluminide ~~oxide~~, we would have had additional lines.

Q The nickel you found was that elemental nickel or of another form?

A From the data that I have, it appears to be elemental nickel. If there was a solution of aluminum in there the lattice parameter of the material would expand in this case and we have data for the expansion of the unit cell to about 20 ~~atoms~~ atomic percent.

That very strong line that you see, 2.03, if you had aluminum in there to that degree and that line would be about 207, 208 -- we couldn't possibly mistake it.

Q Would you analyze what appears in Figure 1 of the report -- describe it to us please.

A Figure 1 which is a poor reproduction, you have got some numbers in here -- there is one, two, three, four, five, six and so forth. Those were particles which we characterized by using the energy dispersing analyzer and we looked at all of those positions indicated on the micrograph and they were primarily aluminum. Then my subsequent analysis characterized they were aluminide.

* * *

Q Here on your report it says, "Consists mainly of elemental nickel with a trace of gamma aluminum oxide.

A That's true.

Q How much is a trace?

A In this case -- now, I will have to explain something. When we deal with numbers you always have to give some qualifying statements here. In this case when you are dealing with a metal versus an oxide you can see an oxide in about one percent as -- as a rule. Perhaps less, but if you had the situation which was a little different whereby you were -- you had an oxide and you were looking for elemental material in there then maybe it would be two or three percent before you could detect the metal.

See, this is just inherent in diffraction patterns that you obtain.

Q Well, how much --

A I say around one percent is something that I --

Q In other words at best there was about one percent aluminum oxide in that sample?

A Now, this is -- I am making a very -- the analysis I am making now is very selective. Now, I am taking this

off the surface. Now, whether this is contained throughout the sample I have no way of knowing.

Q What would you normally expect, higher oxide content on the surface?

A In this case, yes, I would.

Q I see.

So in the area where you would expect a higher oxide content you found about one percent aluminum oxide; is that correct?

* * *

Q In your cross there was some discussion of the aluminum in some form that was found on the coating. Did you later find out what form that aluminum was in?

A Yes, it's in --

Q And what was that?

A It's indicated on that table. It's a gamma oxide.

Q Therefore there was no aluminum coating, as far as your analysis shows?

A My X-ray diffraction data does not show that.

Q And did your analysis show any aluminide or inter-metallic phase in the coating?

A No, it does not.

* * *

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